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A SYLLABUS OF SOLID GEOMETRY USED IN THE ETHICAL CULTURE SCHOOL.

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During the past year, the high school department of the Ethical Culture School has had several sets of papers stenciled for the use of pupils taking courses in mathematics. Many of our visitors have not only shown great interest in these papers, but have gone so far as to ask for copies. In view of the fact that we have only a limited number for our own use, it has been deemed wisest to meet this request in some other way. We hope from time to time to publish these stencils so that all those who are really interested in them may avail themselves of copies.

The sets of papers thus far stenciled may be classified under two heads:

First: Those that are wholly original.

Second: Those which make little pretence at originality except for the selection and arrangement of the material used.

The following syllabus in solid geometry falls under the former of these two groups. A few words as to the history of this syllabus may be in place. I had taught solid geometry for six years and each year was more and more convinced that it must be possible to group the theorems usually studied in a course in solid geometry so that none of the logical sequence should be sacrificed, while it should be psychologically better adapted to the use of our pupils. Though I used one of the standard texts all these years, I had gradually introduced so many changes in the syllabus that finally the point was reached where the text was simply a burden and confused rather than aided the pupils. Consequently, I decided to use no text whatever during the seventh year of the course, that was 1910 to 1911.

As each section of the syllabus was started I gave the class the topic of that section. Under the heading given we together attempted to discover what facts we could, gradually arranging these facts in logical sequence so as to make a perfect chain. Thus many a theorem was inserted as it was found necessary in

order that the truth of another might be established. After each section was completed, I had the theorems typewritten and placed in the hands of the pupils.

At the close of the course the mathematics faculty decided that with practically no change the syllabus should be stenciled and used in the future in the place of a text. During the year 1911 to 1912 another member of the faculty gave the course to test the syllabus. His verdict has made me feel ready to publish the syllabus so that others may try it also should they see fit. My colleague has made the statement that he believes he will never be willing to go back to the old.

Because I feel sure that my reasons for grouping the theorems as I did will be self-evident if the syllabus is carefully read, I append the syllabus without further explanation or apology. Should there be any doubt in the mind of the reader, I shall be glad to attempt to answer any questions he may frame.

SECTION I.

Parallels and Their Application to the Prism, Cylinder, Pyramid, and Cone.

Definition. Plane.

Postulate 1. A plane is determined by a straight line and a point without.

Proposition 1. (*a*) Three points not in the same straight line
(*b*) Two intersecting straight lines
(*c*) Two parallels
} Determine a plane.

Corollary. Two intersecting planes determine a straight line.

Proposition 2. The lines of intersection of three planes intersecting in pairs are either concurrent or parallel.

Corollary. If two lines are parallel to a third line in space they are parallel to each other.

Definition. Coplanar.

Proposition 3. Two non-coplanar angles having their sides parallel are either equal or supplementary.

Definition. Line perpendicular to a plane, and plane perpendicular to a line.

Corollary. When one of two parallels is perpendicular to a plane the other is also.

Definition. Parallel planes.

Proposition 4. The intersections of two or more parallel planes with another plane are parallel.

Corollary. Parallel sects included between parallel planes are equal.

Proposition 5. Straight lines cut by three or more parallel planes are cut proportionally.

Definition. Line parallel to a plane, and plane parallel to a line.

Proposition 6. Any plane containing only one of two parallel lines is parallel to the other.

Proposition. 7. A line parallel to a plane is parallel to the intersection of this plane with any plane passed through the line.

Corollary. If each of two intersecting straight lines is parallel to a given plane their plane is parallel to that plane.

Proposition 8. Planes perpendicular to the same straight line are parallel.

Proposition 9. A straight line perpendicular to one of two parallel planes is perpendicular to the other.

Corollary 1. Two intersecting planes cannot both be parallel to a third plane.

Corollary 2. Two planes parallel to a third plane are parallel to each other.

Definition. Prismatic surface.
Prismatic space—convex, concave, cross.
Edges, lateral.
Faces.
Transverse section, right, oblique.
Prism—oblique.
Bases and base edges.
Triangular prism, square prism, pentagonal,.....*n*-gonal.

Proposition 10. Parallel transverse sections of a prismatic space are congruent polygons.

Corollary 1. The bases of a prism are congruent.

Corollary 2. The lateral edges of a prism are equal.

Corollary 3. The lateral edges of a prism are parallel.

Corollary 4. The faces of a prism are parallelograms.

Proposition 11. Only one line can be perpendicular to a given plane at a given point in it or from a given point outside it.

Corollary. Two lines perpendicular to the same plane are parallel.

Definition. Right section of a prism.
Right prism.
Altitude.
Lateral area.
Total area.

Proposition 12. The lateral area of a prism is equal to the product of the perimeter of a right section and a lateral edge.

Corollary 1. The lateral area of a right prism is equal to the product of its altitude and perimeter of its base.

Corollary 2. The total area is equal to the sum of the lateral area and twice the base.

Definition. Curved surface.
A cylindrical surface.
Generatrix.
Directrix.
Element.
Cylindrical space.
Transverse section.
Right section.
Cylinder—oblique, right, circular.
Cylinder of revolution.
Cylinder—convex, concave, cross.

Proposition 13. Parallel transverse sections of a cylindrical space are congruent.

Corollary 1. The bases of a cylinder are congruent.

Corollary 2. The elements of a cylinder are equal.

Corollary 3. Every plane section of a cylinder containing an element is a parallelogram.

Proposition 14. The lateral area of a cylinder is equal to the product of the perimeter of a right section and an element.

Corollary 1. The lateral area of a cylinder of revolution is equal to the product of the circumference of its base and its altitude.

Corollary 2. The total area of a cylinder is equal to the sum of the lateral area and twice the base.

Definition. Similar cylinders of revolution.

Proposition 15. The lateral areas, or total areas, of similar cylinders of revolution are to each other as the squares of their radii, or as the squares of their altitudes.

Definition. Pyramidal surface.
Pyramidal space.
Edges.
Faces.
Vertex.
Transverse section.
Pyramid.
Base.
Vertex.
Altitude.
Frustum of a pyramid.

Proposition 16. Parallel transverse sections of a pyramidal space are similar.

Corollary 1. Parallel transverse sections of a pyramid divide edges and altitude proportionally.

Corollary 2. In pyramids having equal bases and equal altitudes, transverse sections parallel to the bases, and equidistant from them, are equal; in those having congruent bases these sections are congruent.

Corollary 3. The bases of a frustum of a pyramid are similar.

Definition. Regular pyramid.
Slant height of a regular pyramid.
Slant height of a frustum of a regular pyramid.

Proposition 17. The lateral area of the frustum of a regular pyramid equals one half the product of its slant height and the sum of the perimeters of its bases.

Corollary 1. The lateral area of a regular pyramid equals one half the product of its slant height and the perimeter of its base.

Corollary 2. The total area of a frustum of a regular pyramid is equal to one half the product of the sum of the perimeters of its bases and its slant height, increased by the sum of its bases.

Definition. Conical surface.
Directrix.
Generatrix.
Vertex.
Nappes (upper, lower).
Conical space.
Transverse section.
Cone.
Base, vertex, altitude, slant height.
Circular cone.
Axis.
Right circular cone.
Oblique circular cone.
Inscribed pyramid.

Proposition 18. Parallel transverse sections of a conical space are similar.

Corollary. Plane sections parallel to the base of a circular cone are circles.

Proposition 19. The lateral area of a frustum of a right circular cone equals one half the product of the slant height and the sum of the circumference of its bases.

Corollary 1. The lateral area of a right circular cone equals one half the product of its slant height and the circumference of its base.

Corollary 2. The lateral area of a frustum of a cone of revolution is equal to the product of the circumference of the midsection and its slant height.

Corollary 3. The lateral area of a frustum of a cone equals the product of the height and the circumference of a circle whose radius equals the sect of the perpendicular to the slant height at its midpoint, terminated by the axis.

SECTION II.

PERPENDICULARS, AND THE MEASUREMENT OF DIHEDRAL ANGLES.

Proposition 20. If a straight line is perpendicular to each of two intersecting lines it is perpendicular to the plane of those lines.

Definition. Pencil of planes.
Axis.
Dihedral angle.
Edges.
Faces.
Plane angle of a dihedral angle.

Proposition 21. Two dihedral angles having equal plane angles are equal, and conversely.

Corollary 1. Dihedral angles compare as their plane angles.

Corollary 2. Dihedral angles are measured by their plane angles.

Corollary 3. If a straight line is perpendicular to a plane any plane containing that line will be perpendicular to the plane.

Corollary 4. If in one of two perpendicular planes a line be drawn perpendicular to their intersection, it is perpendicular to the other.

Corollary 5. If two planes are perpendicular to each other, a straight line drawn from any point in one, perpendicular to the other, lies in the first.

Corollary 6. If two planes are perpendicular to a third their intersection is perpendicular to the third.

Proposition 22. Every point in the plane bisecting a dihedral angle is equidistant from the faces of the angle.

Corollary. The locus of a point equidistant from two intersecting planes consists of the planes which bisect the dihedral angles formed by the two intersecting planes.

SECTION III.

Polyhedral Angles and the Spherical Polygon.

Definition. Sphere.
Sphere surface.
Center, radius, diameter.
Plane section.

Proposition 23. The plane section of a sphere is a circle.

Definition. Great circle.
Small circle.
Arc, quadrant.
Axis of a circle.
Poles of a circle.

Corollary 1. The axis of a circle passes through its center.

Corollary 2. The diameter of a sphere through the center of a circle is the axis of that circle.

Corollary 3. Circles on the same sphere equidistant from the center are equal and conversely.

Corollary 4. Circles on the same sphere unequally distant from the center are unequal in the opposite order, and conversely.

Corollary 5. Great circles on the same sphere are equal.

Definition. Polyhedral or solid angles.
Edges.
Faces; face angles.
Naming solid angles.
Congruent polyhedral angles.
Symmetric polyhedral angles.
Opposite polyhedral angles.

Proposition 24. In any trihedral angle the sum of any two face angles is greater, and their difference is less than the third face angle.

Definition. Spherical polygon.
Opposite spherical polygons.
Symmetric spherical polygons.
Vertices of a spherical polygon.
Angles of a spherical polygon.
Sides of a spherical polygon.

Corollary. In any spherical triangle the sum of any two sides is greater, and their difference less than the third side.

Proposition 25. The sum of the face angles of any convex polyhedral angle is less than a perigon.

Corollary 1. In any convex spherical polygon, the sum of the sides is less than a circumference.

Definition. Polyhedron; regular convex.

Corollary 2. There are only five regular convex polyhedrons.

Proposition 26. Two trihedral angles are congruent or symmetric if two face angles and the included dihedral angle, or two dihedral angles and the included face angle, or three face angles of one are equal to two face angles and the included dihedral angle, or two dihedral angles and the

included face angle, or three face angles of the other.

Corollary. Two spherical triangles on the same or equal spheres are congruent or symmetric if two sides and the included angle, or two angles and the included side, or three sides of one are equal to two sides and the included angle, or two angles and the included side, or three sides of the other.

Proposition 27. If each of two points (not the extremities of a diameter) are a quadrant's distance from a third point on the surface of a sphere, this third point is the pole of the great circle through the first two points.

Definition. Measurement of distance on the surface of a sphere. Polar distance.

Proposition 28. All points on the circumference of a circle are equidistant from the pole of that circle.

Corollary. The polar distance of a great circle is a quadrant.

Definition. Polar triangle.

Proposition 29. If one spherical triangle is the polar triangle of a second, the second is the polar triangle of the first.

Proposition 30. Any angle of a spherical triangle is measured by the supplement of the opposite side of its polar triangle.

Corollary 1. The sum of the angles of a spherical triangle is greater than one, and less than three straight angles.

Corollary 2. The sum of the dihedral angles of a trihedral angle is greater than one and less than three straight angles.

SECTION IV.

Spherical Surfaces.

Proposition 31. The area of the surface of a sphere is equal to that of four great circles.

Definition. Zone.
Bases of a zone.
Altitude of a zone.

Corollary 1. The area of a zone is equal to the product of its altitude and the circumference of a great circle.

Corollary 2. Areas of the surfaces of spheres compare as the squares of their radii: those of zones as the product of their altitudes and radii.

Definition. Bi-rectangular triangle.
Tri-rectangular triangle.
Lune.

Proposition 32. The area of the surface of a sphere is equal to that of eight tri-rectangular triangles: that of a lune to twice the product of its angle and the area of a tri-rectangular triangle.

Proposition 33. Symmetric triangles on the same sphere are equivalent.

Definition. Spherical excess of a polygon.

Proposition 34. The area of a spherical triangle is equal to the product of its spherical excess and the area of a tri-rectangular triangle.

SECTION V.

VOLUMES.

Proposition 35. Prisms cut from the same prismatic space and having equal lateral edges are equal.

Corollary 1. An oblique prism is equal to a right prism whose base and altitude are a right section and lateral edge of the oblique prism.

Corollary 2. Right prisms having equal altitudes and congruent bases are congruent.

Definition. Parallelopiped; right, rectangular.

Corollary 3. An oblique parallelopiped is equal to a rectangular parallelopiped having equal base and equal altitude.

Proposition 36. Rectangular parallelopipeds having equal bases compare as their altitudes.

Proposition 37. Rectangular parallelopipeds having equal altitudes compare as their bases.

Proposition 38. Any two rectangular parallelopipeds compare as the products of their three dimensions.

Corollary 1. The volume of a rectangular parallelopiped is equal to the product of its base and altitude.

Corollary 2. The volume of any parallelopiped is equal to the product of its base and altitude.

Corollary 3. The volume of any parallelopiped is equal to the product of a right section and a lateral edge.

Proposition 39. A plane passed through two diagonally opposite edges of a parallelopiped divides it into two equal triangular prisms.

Corollary 1. The volume of a triangular prism is equal to the product of its base and altitude.

Corollary 2. The volume of any prism is equal to the product of its base and altitude.

Corollary 3. Prisms of equal bases compare as their altitudes; of equal altitudes, as their bases; of neither equal bases nor altitudes, as the products of their bases and altitudes.

Corollary 4. The volume of a cylinder is equal to the product of its base and altitude.

Proposition 40. Pyramids of equal bases and altitudes are equal.

Corollary 1. The volume of a triangular pyramid is equal to one third the product of its base and altitude.

Corollary 2. The volume of any pyramid is equal to one third the product of its base and altitude.

Corollary 3. Pyramids of equal bases compare as their altitudes; of equal altitudes, as their bases.

Definition. Frustum of a pyramid.

Frustum of a cone.

Corollary 4. The volume of a frustum of a triangular pyramid is equal to the product of one third its altitude and the sum of its bases and a mean proportional between its bases.

Corollary 5. The volume of the frustum of any pyramid is equal to the product of one third its altitude and the sum of its bases and a mean proportional between its bases.

Corollary 6. The volume of a frustum of a cone is equal to one third the product of its altitude and the sum of its bases and mean proportional between its bases.

Corollary 7. The volume of a cone is equal to one third the product of its base and altitude.

Definition. Truncated prism.

Corollary 8. The volume of a truncated triangular prism is equal to the sum of three pyramids having as bases that of the prism, and as vertices the vertices of the section of the prism.

Definition. Spherical sector, base, altitude.
Spherical cone.
Spherical pyramid.
Spherical segment, bases, altitude.
Spherical wedge or ungula.

Proposition 41. The volume of a sphere is equal to one third the product of its surface and radius.

Corollary. The volumes of spherical sectors, cones, pyramids, and wedges are equal to one-third the product of their respective bases and the radius of the sphere.

Proposition 42. The volume of a spherical segment is equal to one half the product of its altitude and the sum of its bases increased by the volume of a sphere having as diameter the altitude of the segment.

THE PIEDMONT REGION.

That part of the Carolinas which lies immediately southeast of the Blue Ridge, in what is known as the Piedmont region, has long been of both scientific and commercial importance, largely on account of the variety and abundance of its minerals. In fact, in the number of its mineral species North Carolina is said to surpass any other state in the Union, and a great variety of minerals has been found in South Carolina. Mining in this region dates back from the time of settling of America, and early Spanish and English accounts of the discovery and recovery of metals are numerous. The principal mineral resource is gold. Iron has been mined to a considerable extent and within recent years the monazite industry has attained some importance. Besides these materials, tin, copper, lead, manganese, pyrite, mica, barite, corundum, clay, limestone, and granite are or have been found and worked to some extent.

CLIMATIC VARIATION IN CALIFORNIA.

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Each morning at eight o'clock (Washington time) trained observers in some two hundred weather bureau stations in all parts of the United States carefully observe and record the condition of the weather. Within a few hours a map showing the existing conditions, and giving a forecast for the thirty-six hours immediately following, is mailed to interested persons in every state and large city in the Union. In addition, the local forecast is published in more than two thousand daily papers, and much information is sent out by telegraph and telephone. This is a striking illustration of our interest in weather conditions. Expensive as is this work, the saving of life and property resulting from it is so great that no well-informed person doubts the wisdom of the expenditure.

An unseasonable frost may injure the corn crop to the extent of hundreds of thousands of dollars. A blizzard may work havoc on the cattle ranches of the Northwest. The rapid melting of snow on the Rocky Mountains, due to the passing of a warm wave, may cause a destructive flood in the Mississippi River. These are a few of the important ways in which weather changes influence our lives. In countless minor ways our daily actions and feelings are shaped by the atmospheric conditions that surround us.

Climate, which is but the average condition of weather, has ever been the most vital factor in man's physical environment. Primitive man is almost at the mercy of climate, and the most highly civilized of human beings can never, in any large measure, escape from its direct or indirect control.

The more complex society becomes, the more far-reaching are the effects of climate. A long-continued drought causing a partial failure of the wheat crop in the United States, Russia, Canada, India, or Australia, reacts unfavorably upon the people of the British Isles. The southward extension of a cold wave damaging the cotton crop in the South is a direct loss to the people of several European countries. A serious flood in China means a falling off in the exports of other countries to this land. With improved transportation facilities, people now travel thousands of miles to enjoy, even temporarily, such climatic conditions as appeal to them.

That climate is subject to considerable changes within the ordinary span of human life, is a very common belief. Elderly

people are very prone to assume that the climate is quite different from what it was in the days of their youth. It is frequently stated that rainfall in California is decreasing, and in proof of this assertion it is pointed out that small streams do not now flow for so large a part of the year as they formerly did.

The prosperity of Great Britain is founded upon her coal supplies; Sweden depends largely upon lumber; Cuba upon sugar and tobacco, but California, to an unusual degree, depends upon climate. This applies not simply to the products of the soil, but to human enjoyment as well. The tremendous increase in population during the last decade (sixty per cent) is due primarily to climatic conditions. If the climate of California is undergoing material change, then this prosperity may be but temporary, and some of the great projects under way will be of slight advantage. It is, therefore, of especial importance that accurate information concerning climatic conditions be made public.

Beginning with the year 1894, Los Angeles and vicinity experienced the longest period of drought that has occurred in this section since the establishment of the Weather Bureau Service in Los Angeles in the year 1877. Before the drought came to a close there was a shortage of water. As a consequence the price of hay and grain rose. Many horses were given away or killed because their owners could not afford to feed them. Quite naturally many people came to the conclusion that the climate was becoming more arid.

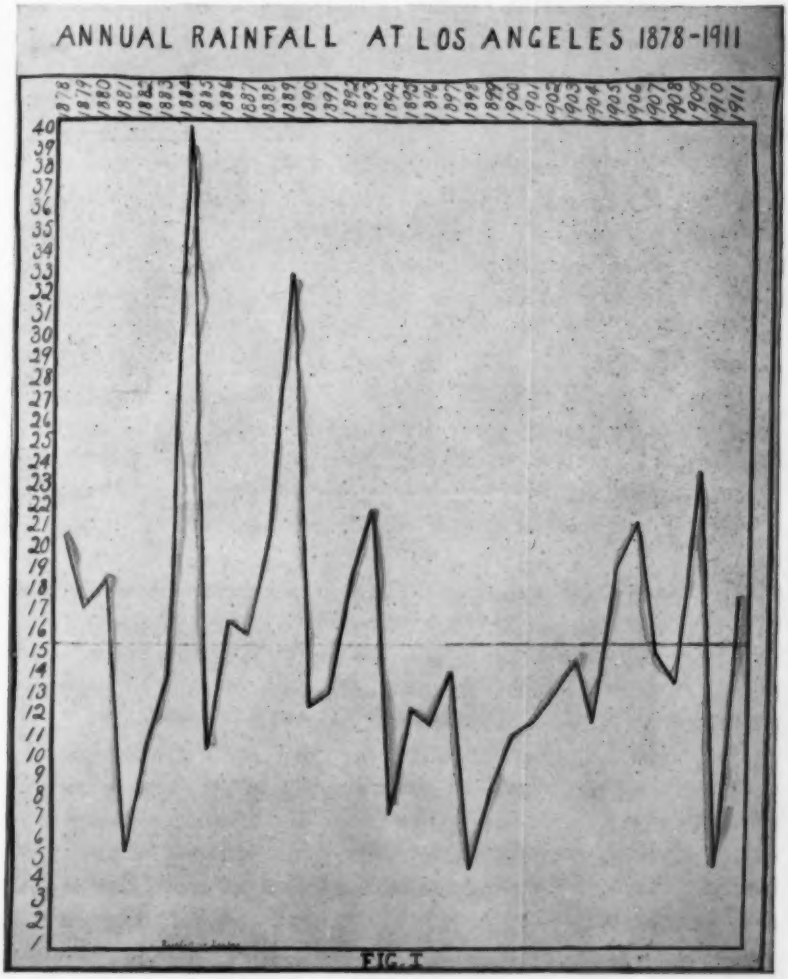
In December, 1904, Mr. Charles M. Hatfield contracted with certain business men of the city of Los Angeles to produce eighteen inches of rain between December 15, 1904, and May 1, 1905. Mr. Hatfield's experiments were carried on at the Esperanza Sanitorium just north of Pasadena. During the period mentioned, the precipitation in Los Angeles amounted to 17.43 inches, while the mean for the same period is 13.08 inches.

In the month of November, 1904, water began to escape from the canals in Imperial Valley and flow into Salton Sink. In October, 1905, practically the full flow of the Colorado was diverted into this ancient basin. During the year 1905 Arizona's precipitation amounted to 26.6 inches, being 14.85 inches in excess of the average. During 1906 the precipitation was above the average in Arizona and in southern California also. The belief that Salton Sea, a body of water which in 1906 was about sixty miles long, eight miles wide, and had an average depth of twenty-

five feet, had caused this more than average rainfall, was quite general.

Our problem is to determine to what extent the climate of California has varied during the period covered by the work of the weather bureau. As, owing to our relation to the prevailing winds and the Pacific Ocean, there can be little variation in temperature from season to season, and from year to year this phase of the problem is practically eliminated. Most of the essential facts brought out in the text are represented graphically. I have attempted to answer the following questions:

First: Is the annual precipitation in California undergoing any regular variation?



As has been pointed out, a Weather Bureau Service has been maintained in Los Angeles since 1877. Figure 1 shows that the average annual precipitation for the period covered, thirty-four years, is 15.86 inches. The maximum annual rainfall occurred in 1884, amounting to 40.29 inches. The minimum, 4.83 inches, fell in 1898. During the thirty-four year period the variation was, therefore, 24.44 inches, or about one and one-third times the average for the year.

While this range is considerable, it is to be noted that but twice during the period did the annual rainfall exceed twenty-five inches—in 1884 and in 1889. During five years only has the yearly rainfall been less than ten inches—in 1881, 1894, 1898, 1899, and 1910. During twenty-four of the thirty-four years the variation was less than thirty per cent of the average annual rainfall.

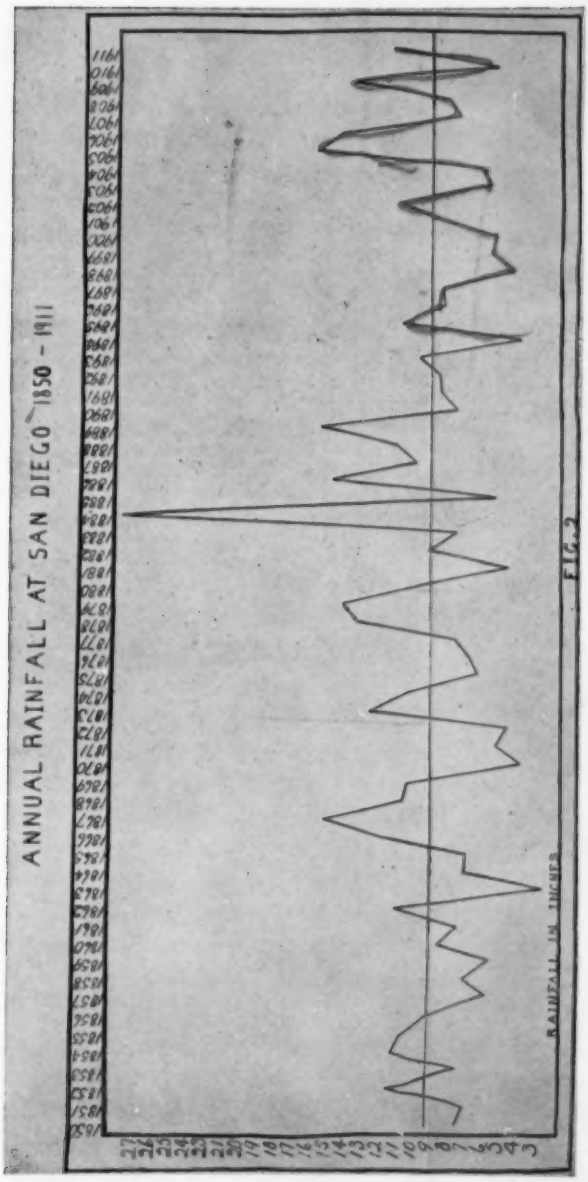
Taking the average for ten year periods we find that the first decade registers 17.09 inches, the second 16.64, and the third 13.25 inches. The average for the third decade when compared with the mean annual rainfall shows a decrease of about thirteen per cent. When it is kept in mind that the first decade includes the two wettest years of which we have any record, and that the third decade includes the year 1910, during which the precipitation exceeded the minimum for the thirty-four year period by but .06 of an inch, the decrease loses much of its force.

The graph further shows that to a certain extent there is a grouping of wet and dry years. The years 1878, 1879, and 1880 may be classed as wet, while 1881, 1882, and 1883 were dry years. Again 1886, 1887, 1888, and 1889 were wet years, while 1894 to 1904, inclusive, were dry years. The years 1905, 1906, 1909, and 1911 were wet.

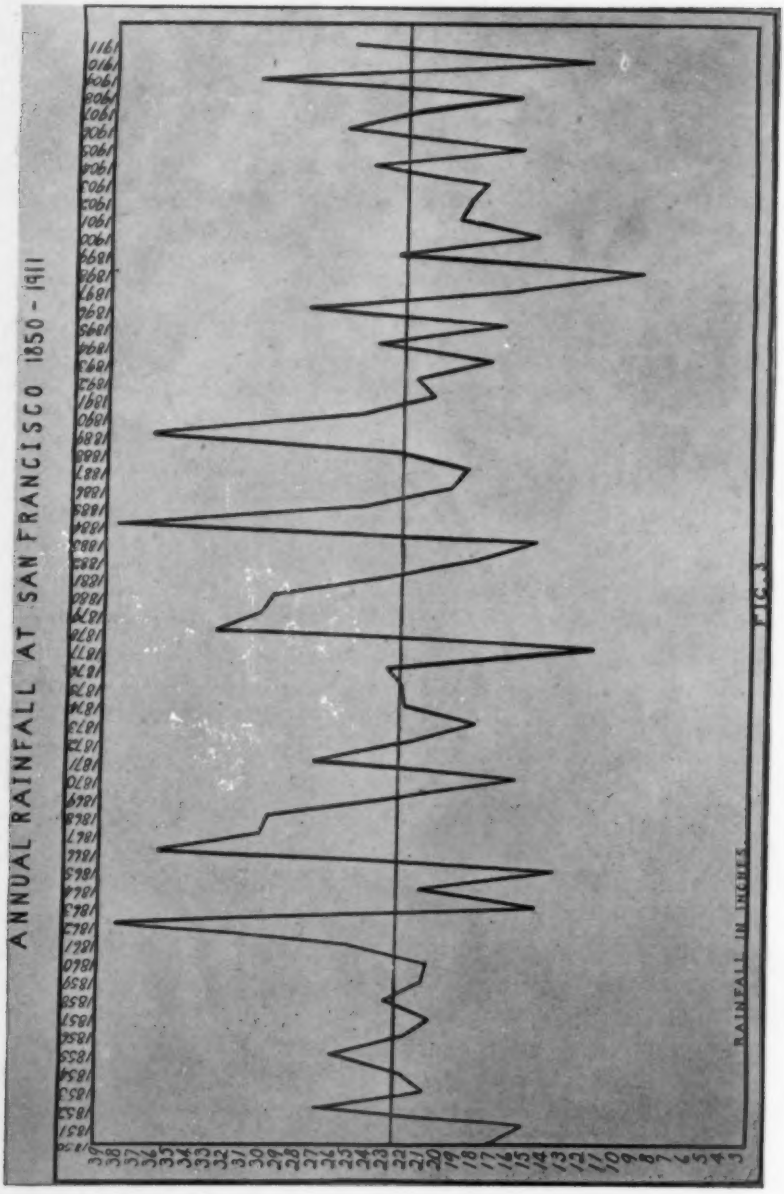
The eleven year period of drought, the excessively wet years of 1884 and 1889, and the unusually dry years of 1898 and 1910 are the most striking facts brought out. In spite of this it is evident that the decrease in rainfall at Los Angeles has been very slight, and might with some reason be called accidental.

Weather conditions have been recorded in San Diego for a period of sixty-two years. Figure 2 shows that the average annual rainfall for that period is 9.54 inches. The maximum, which occurred in 1884, is 27.57 inches. The minimum, 3.02 inches, fell in 1863. In this case the range is more than twice the yearly average.

For the first decade the average is 8.74 inches; for the second,



9.65; for the third, 8.98; for the fourth, 11.98; for the fifth, 8.14, and for the sixth, 10.13. So far as this period of sixty-two years is concerned, there is thus positive proof that the annual precipitation at San Diego *is not decreasing*. It will be observed that there is a regular alternation of the ten year average, below and above the mean annual precipitation.



The records furnished by the Weather Bureau Service at San Francisco cover a period of sixty-two years. As shown by Figure 3 the mean annual rainfall is 22.83 inches. Dividing the period into decades, we find that the average annual precipitation for the first ten year period is 21.84 inches; for the second, 26.58; for

the third, 22.93; for the fourth, 25.06; for the fifth, 20.51; and for the sixth, 21.05. The maximum ten year average is about ten per cent greater than the mean annual rainfall, while the minimum ten year average is about ten per cent less than the mean annual. The figures show definitely that there has been neither a regular increase nor decrease in precipitation.

Sacramento furnishes a record of the weather covering a period of sixty-two years, the mean annual precipitation being 19.41 inches. The average by decades is as follows: 18.05 inches, 20.55 inches, 17.91 inches, 21.74 inches, 18.83 inches, 19.95 inches. It is interesting to note that the average for the ten year periods has regularly alternated above and below the mean annual. As in the case of Los Angeles, the wettest ten year period was that from 1880 to 1889. The maximum ten year average is about ten and one-half per cent greater than the mean annual, while the minimum ten year average is about ten per cent less than the mean annual.

At Stockton a record has been kept since 1867, the mean annual precipitation for the period being 14.63 inches. By decades the averages are as follows: First, 14.60 inches; second, 13.90 inches; third, 14.33 inches, and fourth, 15.01 inches. In this case no ten year average departs from the mean by so much as ten per cent. It seems safe to draw the conclusion that California is not tending toward increased aridity.

Second: Is the occurrence of heavy rains before the beginning of the rainy season, followed by a light seasonal rainfall? This question is very commonly answered in the affirmative. In southern California the months from November to April, inclusive, constitute the rainy season. In fact, ninety-six per cent of the seasonal precipitation occurs during this period.

The average September rainfall in Los Angeles is .13 inches. In September, 1889, the rainfall at Los Angeles was .33 inches, and the seasonal precipitation 34.84 inches, or more than twice the mean. In September, 1894, rain fell to the amount of .73 inches, while the seasonal fall amounted to 16.11 inches. During September, 1903, the precipitation registered .43 inches, and that for the season amounted to 8.72 inches. The rainfall in September, 1908, was 1.22 inches, while the seasonal fall was 19.18 inches. During the thirty-four years covered by the records of the Weather Bureau Service there were but four excessively wet Septembers, and three of these were followed by seasons having a rainfall above the normal.

The mean October rainfall in Los Angeles is .72 inches. In 1883 the October precipitation amounted to 1.42 inches, while that for the season was 38.18 inches. During October, 1889, the precipitation was 6.96 inches, or nine times the mean for the month, while during the season 34.84 inches of rain fell. The October rainfall in 1897 was 2.47 inches and the seasonal 7.06 inches. There fell during October, 1889, rain to the amount of 1.59 inches, while during the season the fall registered 7.91 inches. For 1901 the figures are 1.88 inches and 10.60 inches. Thus three excessively wet Octobers were followed by seasons having less than the normal rainfall, and two were followed by seasons having more than the normal rainfall. There is apparently no ground for the assertion that early rains are followed by a dry season.

Third: Has the Salton Sea increased the rainfall in southern California?

The area of Salton Sea was in 1906, approximately 480 square miles, or 307,200 acres. This area was covered to the average depth of twenty-five feet. This volume of water would cover 7,680,000 acres to the depth of one foot, or 92,160,000 acres to the depth of one inch. The area of southern California is, in round numbers, 50,000 square miles, or 32,000,000 acres. If Salton Sea had in 1906 been completely evaporated, the water vapor condensed, and the rain equally distributed over southern California, it would have added about three inches to the seasonal rainfall. So far as Salton Sea is concerned there would thus have been nothing left to account for the more than mean seasonal precipitation of 1907, 1909, and 1911.

As the prevailing winds blow from the ocean over southern California, it is evident that Salton Sea can have no appreciable effect upon the rainfall of the area. So far as the position of the state is concerned, the rainfall in Arizona might be increased by Salton Sea, but the insignificance of this body of water as a factor in determining the precipitation has been fully shown by Alfred J. Henry in the *National Geographic Magazine*, Volume 18, pages 244-248.

Fourth: Has the removal of forests in California caused a decrease in rainfall?

That deforestation in California and elsewhere has resulted in a decrease in precipitation is very generally believed. It is estimated that 44,000 acres of timber have been cut in the region tributary to Eureka since the establishment of the Weather Bureau Service there. The mean annual rainfall at Eureka is 45.55

inches. By decades since 1887 the precipitation has averaged 47.23 and 45.20 inches. Here we have a decrease, yet in 1909 there fell more than sixty-one inches of rain.

At Crescent City, about sixty miles from Eureka, the average annual rainfall for the period of 1886-1910 is 69.41 inches. For the first decade the average is 69.84 inches, and for the second, 76.74. In this case an increase is shown.

Willits is in a region where an immense amount of timber has been cut. The mean annual rainfall for a period of twenty-nine years is 54.67 inches. Taking nine year periods the rainfall averages 48.75, 55.04, and 59.52 inches.

A record of the rainfall has been kept at Georgetown, El Dorado County, for thirty-eight years. The mean for this period is 58.62 inches. The average rainfall for nine year periods is 58.36, 54.83, 59.34, and 57.32 inches.

The mean annual rainfall at Red Bluff for a period of thirty years is 25.61 inches. The average for the first decade is 23.41, for the second 24.99, and for the third 27.47 inches. Here, in spite of the removal of forests, *the average annual rainfall has increased.*

For the period since 1889 the mean annual precipitation at Sisson is 39.69 inches. The average for the first decade is 35.25 and for the second, 42.41 inches.

At Truckee the mean annual rainfall is 27.12 inches. For the first decade the average is 28.96; for the second, 24.86; for the third, 27.54; and for a period of eight years (the records for 1909 and 1910 being incomplete) the average is 27.63 inches.

We have here the precipitation records for seven stations, each one of which is in a region where deforestation has gone on extensively. Four show a definite increase in rainfall, in two cases the averages for groups of years rises above and falls below the normal, and in but one case is a decrease shown.

As applied to California, at least, there appears to be no ground for the time-honored belief that the removal of forests decreases rainfall.

Fifth: Can rainfall in California or elsewhere be increased by artificial means?

This is a problem that has been pretty thoroughly worked out by our government, many experiments having been carried on in various parts of the Southwest. The results of these experiments go to show that precipitation cannot be materially increased through human efforts. In spite of this, Mr. Hatfield found no

difficulty but a few years ago in entering into an agreement with Los Angeles merchants to produce a certain number of inches of rain for a specified sum of money. As already stated, the precipitation practically reached the specified amount, and this being much above the mean for the period, many quite naturally believed that Mr. Hatfield was responsible. In this connection it is interesting to note that the precipitation at Eureka for the same period of time was 49.56 inches, while the normal is 32.80 inches. At San Diego the precipitation was 13.80 inches, while the normal is 7.62 inches. To claim that the excess of rainfall in the two places named could have been related to the work of Mr. Hatfield is manifestly absurd.

Between December 24, 1905, and March 31, 1906, Mr. Hatfield operated under contract with grain growers in Stanislaus County. Giving Mr. Hatfield a time advantage of one week, we find that between January 1, 1906, and March 31, 1906, there fell in Los Angeles 13.67 inches of rain, while the normal for this period is but 9.08 inches. The precipitation in San Francisco amounted to 13.22 inches, or 1.45 inches in excess of the normal for the period. San Diego received an excess of 3.10 inches, while in Eureka there was a deficiency of .72 inches.

From November 15, 1906, until March 1, 1907, Mr. Hatfield again operated in Stanislaus County, and more than the average amount of rain for the period fell. During the months of December, 1906, and January and February, 1907, the precipitation in Los Angeles amounted to 13.97 inches, or 5.09 inches above the mean. This gives Mr. Hatfield an advantage amounting to fifteen days. During the three months the rainfall at San Francisco amounted to 14.33 inches, being 1.24 inches above the mean. For the same period San Diego received 7.74 inches, which exceeded the mean by 1.19 inches. At Eureka there was an excess amounting to 6.26 inches.

On November 29, 1910, Mr. Hatfield entered upon his thirteenth contract to produce rain, again working for the grain growers of Stanislaus and Merced Counties. His experiments closed April 30, 1911. Again taking the four widely separated stations of San Diego, Los Angeles, San Francisco, and Eureka, we find that for the given time the precipitation at San Diego was 1.28 inches above the mean; at Los Angeles, .59 inches above the mean; at San Francisco there was an excess of 5.48 inches, while at Eureka there was a deficiency amounting to 10.11 inches. It seems evident that rainfall conditions in California have not been influenced by human agencies.

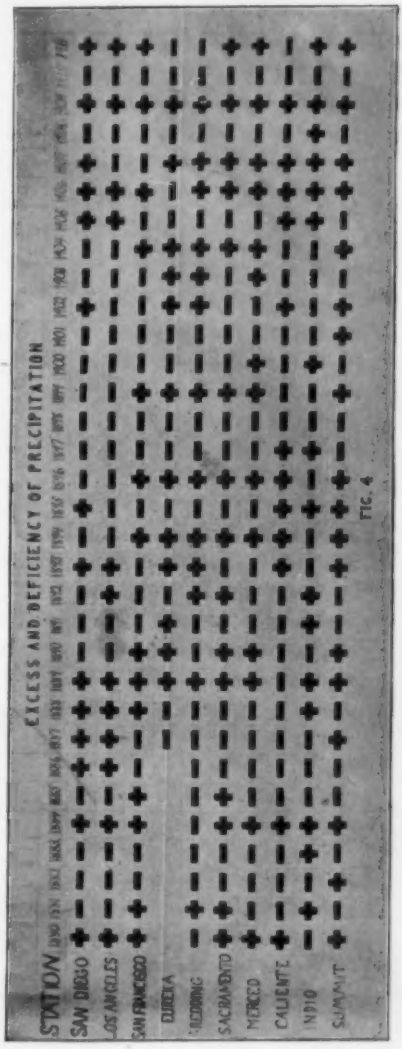


FIG. 4

In order still further to test climatic variation I have selected a number of stations and have made a study of their rainfall conditions. The places were so chosen as to secure (1) a great latitudinal range, (2) a great altitudinal range, (3) a great variation in distance from the ocean, (4) records covering a long period of time. As applied to all of the stations but Eureka, the records cover a period of thirty years or more. The essential facts are represented by Figure 4. Precipitation in excess of the mean annual is indicated by a plus, while a deficiency of rainfall is represented by a minus.

The graph shows that the years 1880, 1884, 1889, 1894, 1896, 1906, 1907, 1909, 1911 were wet years. During the years 1880, 1894, and 1911 seventy per cent of the stations were wet. In 1884 and 1907 the per cent of wet stations was eighty; in 1889 and 1906 it was ninety, while in 1909 all of the stations had more than the mean annual rainfall. In 1906 Eureka, the only station of the ten to register less than its normal rainfall, had a deficiency amounting to but .02 inches.

The years 1882, 1883, 1885, 1886, 1887, 1891, 1897, 1898, 1900, 1901, 1908, and 1910 were dry. During 1885 and 1887 the dry stations numbered seven; in 1882, 1883, 1886, 1891, 1897, and 1900 there were eight; in 1901 and 1908 there were nine, while in 1898 and 1910 all of the stations were dry.

It is interesting to note that during twenty-eight of the thirty-

two years for which the rainfall is recorded in Figure 4, San Diego and Los Angeles agree in having either an excess or a deficiency. San Diego, Los Angeles, and San Francisco agree during seventeen of the years. Sacramento and Merced show an agreement in twenty-seven cases.

The mean annual temperature at Los Angeles is 63° F. The maximum annual temperature for the period covered by the observations is 64.9° for the year 1904. The minimum annual temperature, 60.3°, was recorded in 1894. During seventeen of the thirty-four years for which we have a record, the annual temperature varied from the mean by less than 1° F.

It is very evident that California has suffered no appreciable change in climate during the period since the establishment of the Weather Bureau Service. Variations both in rainfall and in temperature have occurred, but these have been in both directions from the normal. We may expect years of drought and years of excessive rainfall in the future, just as we have experienced them in the past. There is every reason to believe that the laws that have governed climatic conditions in California for untold centuries, will continue to be operative for centuries to come. We may plant orchards, erect public edifices, improve our harbors, and in every way build for the future, confident that "Golden State" will continue to enjoy the climatic conditions that have made it one of the most far-famed regions of the world.

QUARANTINING AGAINST THE HOOKWORM.

A new and rather interesting phase of the hookworm problem has come to the front in San Francisco. After the discovery of the wide prevalence of hookworm in the South, California, too, was found badly afflicted with the pernicious parasite. It was known to exist in the mines of that state, but recently has been found prevalent among Porto Rican and Oriental laborers who are mostly engaged in agricultural pursuits. Probably one third to, perhaps, one half of the immigrants coming from the Orient are infected with the hookworm; an investigation during which 2,255 were examined revealed that 1,077 harbored the intestinal parasite. In San Francisco it has recently been discovered that a number of laborers, chiefly from the West Indies, engaged in market-gardening on a tract of land within the city limits, are afflicted with hookworm and, on account of the danger of transmitting the parasite by uncooked vegetables, the laborers have been quarantined and placed under treatment, and the vegetables from these gardens will not be allowed to be sold in the markets until all evidence and danger of hookworm infection are eliminated. The usual route of the infection is through the skin of the feet, but it is believed that uncooked vegetables carrying the hookworm eggs or larvæ might also be a source of infection. This phase of the question and the method of solving it are rather novel, says *The Journal of the American Medical Association*. Doubtless similar conditions obtain elsewhere, and the San Francisco plan will afford a precedent in meeting them.

COMPOUND HARMONIC MOTION APPARATUS.

By Cyril Ruhlmann,
Spring Hill College, Mobile, Ala.

This apparatus has given excellent satisfaction, as we may judge from the accompanying figures produced by it.

There is nothing new in the method of suspension, but the mechanical device for tracing the figures and making them permanent, I believe, to be entirely new. I would be pleased to know if anybody has ever made use of it before.

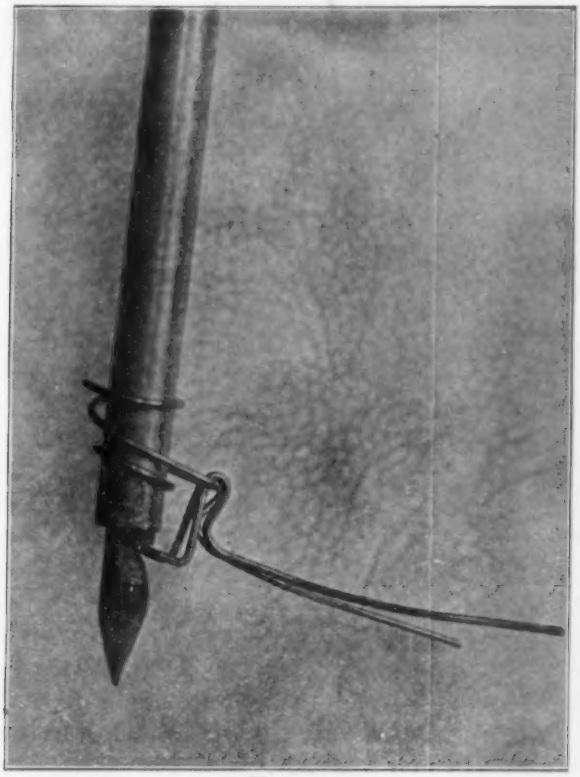


Fig. 1.

The apparatus consists of a sixty-pound cannon ball suspended from the ceiling by two brass wires. A convenient clamp that holds the wires firmly and securely together determines the ratios of vibrations. The clamp is of such construction that it will never allow a wire to escape and yet allows full freedom of motion up or down when the screw is slightly opened. A hole is drilled into the bottom of the ball and this filled with a plug of

soft wood. Into this is driven a ten-inch piece of brass tubing just large enough to allow a pencil to slide up and down very freely, Fig. 1, but without any undue side motion. If necessary a thin collar may be put on the pencil so as to fill the tube. The pencil is notched near the point and a trigger attached to the end of the tube prevents the pencil from falling, and releases it at will, when the ball has the proper motion, thus avoiding irregular and oscillatory tracings as long as the ball is wabbling. The pencil, Fig. 2, is released when the motion of the ball is entirely steady. It is also advisable to do this when the two motions are more or less in turning phase; that is, when the ball is moving very slowly.

FIG. 2.

The figures are traced by the pencil on smoked paper. A soft pencil will trace very slight figures on white paper, and this I tried first; but the paper I use in connection with our seismograph gave me a new idea.

The seismograph records the motions of the earth on a belt of smoked paper eight inches wide by thirty inches in length. These papers are smoked over a broad lamp and are made to pass over the smoking flame by means of revolving cylinders. When the figures are traced on the paper, the carbon is fixed by dipping the paper into a solution of shellac. This gives you figures that can be kept for reference and that show side by side the changes produced by a change of phase.

The way I get the ratios is this. I first count the exact number of vibrations per minute of the whole pendulum. After this I calculate the number of vibrations per minute required to

get the ratios wanted. Then I sit alongside the pendulum, make the short end oscillate at right angles to the long swing, and lower or raise the clamp until I get the number of oscillations wanted. This may take from ten to fifteen minutes. The oscillations are best counted by holding a thin wire in your hand and allowing the ball to touch it at every turn, thus leaving your eyes free to follow the second hand of your watch.

For each ratio I measure the height of the clamp above the ball and record it. Once this is done, any ratio can be had without loss of time by simply moving the clamp to the required height. Care must be had to raise the paper according to the height of the pendulum, which varies as the clamp is moved up or down. If the pencil has to fall too far, the point may be broken or blunted. Instead of smoked paper, smoked glass may also be used. The smoking must not be too thick, otherwise the lines will not be smooth. The even and uniform smoking of paper or glass is a matter of experience.

Different authors that use a similarly suspended pendulum as an illustration of compound harmonic motion, tell you to take a funnel full of sand; or fix a point on the lower end of the ball and cover the floor under it with fine sand, so that the point may trace the figures into it. This sand must be made concave, so that the point will touch everywhere evenly. Tyndall, in his eighth lecture on sound, describes another form of the same pendulum where he used a hair pencil to trace the figures on a glass

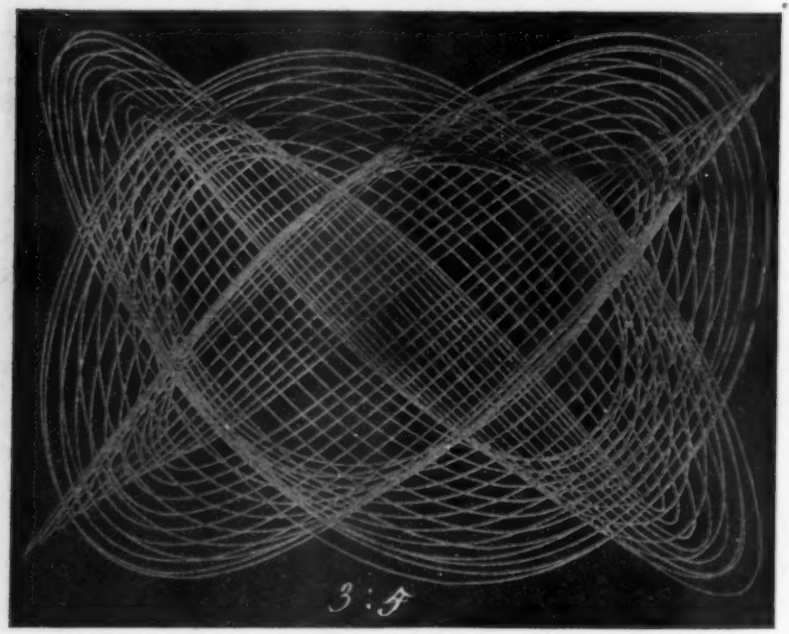
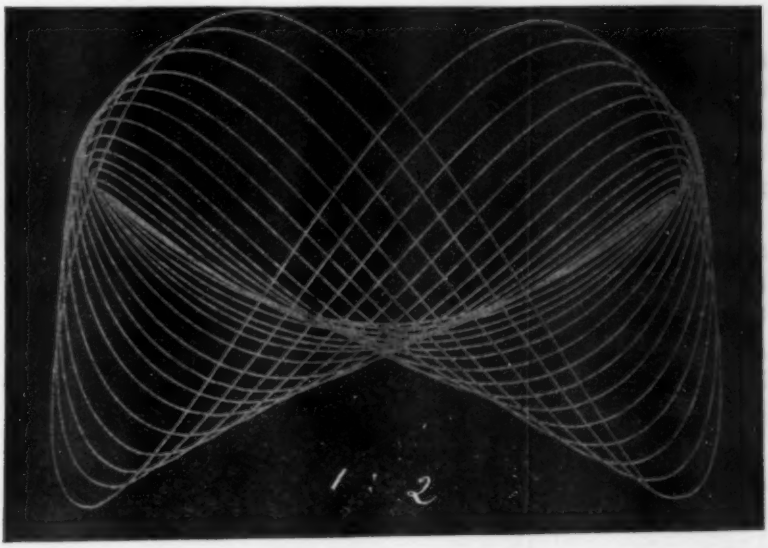


plate covered with white sand. But his system of producing the compound motion kills the amplitude too rapidly. Last year a friend of mine used a chemical separating funnel containing a colored liquid the flow of which was regulated by means of a stop-cock.

If one examines the construction of this apparatus he will see that the sliding of the pencil up and down the brass tube overcomes the difficulty of tracing a figure on a flat surface with an instrument that moves in a curve above it. The friction of the weight of the pencil against the paper; and that of the point on the paper and of the side of the pencil against the tube is so slight that the heavy ball will lose its amplitude very slowly. The trigger that holds the pencil is made from the same brass

wire as the suspension. It is made in such a way that the long ends will pass on either side of the brass tube when raised and stay there, so as not to cause extra friction by pressing against the pencil. The pictures show clearly the two positions.



If the ball be suspended by a single wire it will in the same way trace the figures of simple harmonic motion.

I hope this will prove interesting to some of the readers of SCHOOL SCIENCE AND MATHEMATICS. Later on I may describe some other simple apparatus that I have found to be very efficient for the illustration of first principles.

A STUDENTS' EXPRESS COMPANY.

During the first two or three weeks of September the campus of a college looks more like a railroad freight terminal than a quadrangle of a seat of learning. The campus is a vast jungle of trunks, suitcases, bags, and furniture. Every available wagon in town is pressed into service. A Princeton student saw the possibilities in an express company managed by students and catering entirely to their own fellows. In 1905, the Princeton Express Company was organized by a senior who was working his way. He hired a wagon and called for five "huskies" to act as assistants. Over forty applied for the job. He paid $2.00 a day and a man cleared from $20 to $30 before college formally opened. The enterprise is now making a handsome profit for the president and officers of the company. At the end of the college year in June there is a repetition of the freight terminal scene, and the Students' Express Company reaps another harvest.—*Review of Reviews.*

THE TANGENT GALVANOMETER IN THE HIGH SCHOOL LABORATORY.

By C. L. Vestal,
Carl Schurz High School, Chicago.

One of the marks of modern progress is the tendency toward greater efficiency in all phases of life. Especially is this true in industry. But in education the tendency seems slower in making itself felt. Yet there is no aspect of civilization in which it is more needed. Even our high school youth feel, more or less vaguely, its lack in our school system.

It is not the purpose of this article to take up the problem of efficiency from a purely pedagogical point of view, but as a laboratory teacher the writer has for a long time felt the hampering due to low efficiency methods. It finally resolves itself into the question of how to reach your results with the least expenditure of time and energy, both the teacher's and students'.

Now the high school student, girl as well as boy, is easily interested in the natural physical happenings, if these are presented in terms with which he has some clear association. Particularly is this true of electricity. I am not speaking merely of the exceptional boy, who is never so happy as when "fooling" with amateur electrical apparatus. Practically the whole body of students can be greatly interested in electricity. The constantly increasing part played by it in our daily life, directly and indirectly, is an ever-present stimulus to this interest. I have frequently taken this method: I say to a class, "Now I want you to ask about some of the things which you would like to have explained in the uses of electricity and its doings, which we see all around us every day," and there will be very few members, out of a class of thirty or more, who will not have some natural and spontaneous question in regard to the method of operation of applied electricity. They want to know why and how. And they ask the questions, and naturally want the answers, in the terms which they hear used by others. "What is a volt?" "What is a kilowatt?" "Why do they say kilowatt-hour?" "What is a short circuit?" "What is a fuse?" "How does the meter work?" "What is an ampere?" "What makes a lamp burn out?" "Is that a wire in the lamp?" "What is tungsten?" "What is an arc?" "Why don't they have a bigger wire for 2,300 volts than for

110 volts?" These are only a few samples. They come up as they are suggested to the student by class discussion. And if the work is to mean anything to the boy or girl after it is all done, these questions must be answered, not vaguely, but definitely, so that when these various practical terms are used they will immediately call up in the student's mind a clear-cut conception which will be true, at least by analogy, to what they actually mean.

Now of course if these answers are to be given at all it is evident that there must be laid a foundation of theory, but it is sure to kill interest if the class discussion and laboratory experiment remains theoretical only. Specifically this means that a class demonstration of Oersted's discovery, following as closely as may be the historical circumstances, is the thing needed. Also the historical setting should come into the discussion, with a good mixture of the "human touch" to vitalize it. This the writer follows with a brief, semi-quantitative experiment, which consists in having the students wrap from one to six or seven turns of wire around a little wooden frame so constructed that an ordinary pocket compass can be slipped under the wire. Personally I should prefer to have the compass dial graduated in degrees, but this is not absolutely essential. The main thing is a demonstration to the student of the relation between the direction of swing and the direction of the current. If the dial is graduated as above suggested, it can also be shown that the size of the angle made by the needle with the meridian is not proportional to the number of turns of wire.

This latter statement brings us to the situation against which this article offers a protest. According to the formal method which has for a long time obtained unquestioned in laboratory teaching, the tangent galvanometer is the next "logical" step. But my experience denies that it is the next pedagogical one. Even before the compass experiment is done the question is up: "How many amperes is that?" (The pressure significance of volts will already have been pointed out, probably in electrostatics.) And in answer to this question, what is there to say? There is only one truthful, non-hypocritical answer—you don't know, and in the mere angular swing of the needle there is nothing to tell you. Then the boys will say: "You couldn't make an ammeter or voltmeter

that way then, could you?" And in the face of this the next "logical" step is the tangent galvanometer!

What do we do? Why, we then take up a discussion of the fact, which the compass experiment probably showed, that the increase in deflection is not proportional to the increase in the number of turns of wire. The further fact, which in the experiment the students have noticed and been annoyed by, that the needle oscillates for a considerable time about its final point of rest, is referred to, and its disadvantages pointed out. I then proceed to a very elementary discussion of the tangent galvanometer, explaining its advantage for specially accurate work.

At this point I am forced to compromise in the laboratory between conviction and necessity, for the compelling reason that tangent galvanometers are almost the only measuring instruments provided. So I give as simple an experiment as possible on this instrument. I am free to say that practice will be otherwise as soon as the necessary equipment is available.

During this experiment the difficulties and annoyances incident to the tangent galvanometer become conspicuous. In the introductory discussion a lesson in trigonometry has been necessary. Now while the trigonometry involved is very simple in practice, it is less so in theory, and although the experiment may prove the fact, it does not show the reason why, the current, or rather the magnetic field at the center of the coil, is proportional to the tangent of the indicated angle.

For other elementary experiments in current electricity the tangent galvanometer is still more unsatisfactory. Here it appears still more strongly that the students want to measure in the units by means of which electric quantities are practically handled. Take, for example, an experiment to show the relation between current strength and the size, length, and kind of conductor. Doubling the resistance does not cut in half the angle of swing—not even approximately, unless the deflection is very small. Even when the tangent has been looked up the experimenter does not know how strong the current was. The determination of the reduction factor is an experiment of doubtful value in a high school physics class. Even if the student gets into his mind a clear conception of what he is after, and why it gives the current in amperes when properly used, he is likely to ask impatiently, "What's the use?

Why not use an ammeter in the first place?" And he is right. Why not, indeed?

In measuring resistance with the slide wire bridge the tangent galvanometer is far from an unmixed blessing. The same old annoyances inherent in the principle of the instrument crop up again worse than ever. In making connections properly the multiplicity of binding-posts confuses the student. The chances are that he will not connect to the ones giving the greatest sensitiveness unless his directions specify them by number. Then he waits awhile for the magnet to come to rest. When this finally comes about, he painfully adjusts the plane of the coil in the magnetic meridian. This accomplished, he tries for a balance, and the waiting game is repeated after every trial. The pointer probably has a period of several seconds, and thus much time and temper is consumed. Then, presently—if, as is usually the case in the city schools, four students work at one table—some one of them accidentally strikes the galvanometer, and the adjustment has to be gone over again, with excellent opportunities for the creeping in of the personal element at every step. And perhaps, in addition to all other sources of error, the needle becomes erratic, and the puzzle has to be solved by the instructor, who finds that some magnetic material is too close to galvanometer. This error may even be caused by a girl's corset stays, as she leans close over the instrument to make a reading. In a case like this the instructor can hardly remove the source of error, or even ask that it be done. Taken as a whole, the experiment is a pretty harrowing process.

In spite of its delicacy, the student's D'Arsonval galvanometer is superior for this work. While it is far from deadbeat, its period is much shorter than that of the tangent galvanometer, and the damping effect is considerably greater. In addition, it can be damped if desired by short circuiting through a contact key. Results obtained with it are more accurate than with the tangent species.

To summarize: In the writer's experience the tangent galvanometer, as found in the high school physics laboratory, has almost nothing to recommend it. In fact, I know of no principle, or use of it, in such laboratory which cannot be better performed with a different instrument. The points against it, as compared with other instruments, would stand about as follows:

1. Its theory is too advanced for high school classes.
2. It is a constant annoyance in use, because of:
   (a) the necessity for adjusting the plane of its coil in the magnetic meridian.
   (b) the extremely long period of oscillation of its pointer about final position of rest.
   (c) sensitiveness to stray magnetic fields.
3. Its multiplicity of binding-posts.
4. Its great susceptibility to the personal element as a source of error.
5. Its obscure method of showing current strength.

This last objection, of course, applies only to its use in high school laboratories. In fact, the tangent galvanometer is essentially an advanced, very advanced, laboratory instrument. Few college laboratories require students to use it as a regular measuring instrument in experiments. Its place is in research, in the determination of absolute units.

Now what could take its place? Just plain ammeters and voltmeters. Of course the tangent galvanometer is inherently a more accurate instrument than these, but this accuracy is found only in instruments which are two or three times as costly as those commonly used in the high school. Also to obtain it requires much experience and skill, neither of which the high school student possesses. I venture to say that, for but little more than the money usually paid for the tangent instruments, a voltmeter or ammeter of equal grade can be obtained. However, I would recommend nothing but a good grade of instrument, and in "good" I do not include the "student's voltammeter" put on the market by the laboratory supply houses. It is better to get a first-class article, and manage for a while with fewer of them, than to take an inferior instrument.

There can be had, for less than $20, an ammeter or voltmeter, range 0—10 or 0—15, which can be used with either direct or alternating current. It is a Thomson inclined coil instrument, is practically dead-beat, and its accuracy is sufficient for any school laboratory purpose. The greatly increased satisfaction shown by the students in their work when they are given instruments on which the readings are direct is surprising. These mentioned are very rugged, are not ticklish about stray magnetic fields, nor peevish unless placed in the magnetic meridian.

SUGGESTED SYLLABUS OF HIGH SCHOOL ZOOLOGY.[1]

A. Introduction.

In making this second step toward the formulation of a syllabus for the teaching of biology in the high schools of Illinois, your committee desires to refer you to the following statement made in the introduction to our report last year:

"A course in high school biology should seek the following, among the possible things:

"1. The production and conservation of a vital interest in plants and animals.

"2. An appreciation of the human values of plants and animals.

"3. The encouragement of the attitude of raising and solving problems concerning plants and animals.

"4. Some ability to use the library, the field, and the laboratory in individual pursuit of these interests.

"5. The ability to sustain interest in these problems through considerable periods.

"6. A sense of the way in which organisms respond to the environing conditions.

"7. An elementary conception of development and of the evolutionary series of animals and plants.

"8. Some knowledge of living material; its organization in plants and animals; its properties and the relation of these to the activities of the organism.

"9. Some experience in classification of organisms—theoretical and practical.

"10. A conception of the place of man in the biological series, along with the conviction that this does not invalidate, but rather heightens, the meaning of all the higher human qualities.

"11. A sane, wholesome appreciation of the origin and meaning of sex, and of its bearing on human life.

"The committee believes that it is not desirable, even if possible, to have uniform courses in biology in the different schools of the state. We believe, however, that all exercises in all schools should be handled in such a way as to secure the 'scientific habit,' which includes among other things—the habit of correct observa-

[1] A report offered by the Committee on Syllabus, of the Biology Section of the High School Conference of the University of Illinois. Presented for discussion at the meeting of November 21-23, 1912. Printing authorized by the following members of the committee: T. W. Galloway, chairman; Otis W. Caldwell, Faith McAuley, G. J. Koons, and T. L. Hankinson, secretary. W. Whitney approves the plan and motive of the outline, but feels that very much more is proposed than can be accomplished, and that, because of this, very many teachers will be unable to choose a course from it with success.

tion; of accurate expression of these observations both by means of notes and drawings; of discriminating between superficial and essential observations; of correct thinking; and of willingness to retest the final conclusions when new evidence appears."

In the report of last year we undertook merely to indicate some general types of exercises which, in our opinion, were essential to an elementary course in zoölogy and in botany. In accordance with our instructions to proceed further with this work, it becomes necessary for us to indicate more exactly the special exercises, under these general types which were approved by you, which might be expected to accomplish the aims upon which we are agreed. This report offers tentatively such a list of topics for the subject of zoölogy.

The committee realizes that this is an unsatisfactory stage in which to report our progress—in that it goes beyond the sure ground of the very general statements in the first report, and yet does not give sufficient detail to justify itself as a manual. Without elaborate description, impossible in the limits of such a report, many of these exercises may appear to teachers as indefinite and equivocal. Effort has been made, however, to add such suggestions as will enable the teacher at least to see workable territory in each of the exercises.

If the conference wishes to go any further in this matter, the next step is the preparation, or the selection, of a practical manual of zoölogy in which each of the topics is elaborated in a suggestive way, with citations to some of the zoölogies in current use in high schools, in connection with which this detailed syllabus might be used. It is hoped that this may be accomplished by the time of the next meeting, in case you decide to take this further step. One such exercise (Exercise No. 1) is given in detail, to illustrate what is possible.

Concerning the list of exercises, offered in the present report, the committee wishes to make the following remarks:

1. It is thoroughly well understood that all the exercises listed here cannot be handled in a scholarly way in one term, or even in two terms. It is equally true that some teachers and some schools will be better fitted to emphasize some of the exercises, and others for equally good reasons will prefer to use others. It is not the purpose to secure perfectly uniform iron-clad courses of zoology in our schools.

2. Teachers should feel free, therefore, to bend such a list of subjects to their needs. It is suggestive rather than final. It is

intended to give a standard which shall include the *chief things for which a secondary course in zoölogy should stand,* and a suggestion of some of the kinds of exercises that may be used to meet these ends.

3. In case a whole year is given to zoölogy, with approximately five periods weekly, some of which ought to be double periods, something like one day could be given, on the average, to each of these proposed exercises. But even under these circumstances it will be found that the exercises are not of equal interest, importance, or difficulty; some may be very much abbreviated, or even omitted, and others will require much more than a double period to work out even in a superficial way. Some of the exercises may readily be elaborated so as to give profitable work for several days. In other instances two or more exercises may be concluded at one period. No teacher must allow any textbook or syllabus to determine the rate of passage through the subject; the interest and interests of the pupils, his own conception of the objects to be reached in the particular course, the degree to which the exercise is accomplishing the proposed objects, and such considerations must control his progress and his emphasis.

4. In schools where only one-half year of five periods a week are given to zoölogy, the teacher and class should select such exercises as seem to them most worth while—provided *some* exercises from *each* of the general realms are selected. The pupil should be induced to work and think in each of these main fields in order to have the subject fairly opened up to him. The amount of emphasis upon each field can well be left to be determined year by year in various schools in accordance with the principles suggested above.

5. The following exercises lend themselves to expansion: 8, 9, 19-29, 34-55, and almost any of those in Series X-XIV. The following are readily subject to abbreviation and combination: 10-13, 58-72, 93-105. Certain groups of exercises may be shortened, and yet retain a large part of their suggestiveness by assigning different exercises to different pupils for careful investigation; the results of these studies to be reported to the class, and there discussed. This is peculiarly true of Series VIII, XI, XIV —and, if necessary, XII and XIII.

6. In respect to order, it will be apparent to the teacher that some of these groups of exercises, if they are to be used at all,

naturally belong where they are placed; others may readily be shifted into adjustment with the text-book in use, or with other conditions confronting the teacher.

Series I and II should naturally come very early; the calendar study for each pupil should be selected as soon as the pupil gets sufficient glimpse of the field to enable him to put some personality into the selection; the study of the representative animal should come while the animals chosen are plentiful and active; the Economic Studies (Series VIII) should come whenever the conditions are best for the study of each of them, since their arrangement is in no sense chronological; the same is true of Series XI—the development of animals. Most of the other series can be shifted to meet the local needs. The studies in Series XIV might very appropriately be assigned, one by one, at opportune points, through the course, for the purpose of enlivening interest and thus of motivating the course.

Finally, your committee in the light of its conviction that rigidly uniform courses are unwise, and in recognition of the diversity of views among equally good teachers would suggest, without any definite recommendation, the following as the possible future, constructive tasks of this section in the interest of the teaching of high school biology in Illinois:

1. The selection, or the formation, of a practical manual of zoölogy on the basis of the present report.

2. The preparation or selection of a practical syllabus and manual of botany in the same general spirit.

3. The preparation of a practical manual of biology, in which botany, zoölogy, and human physiology are really unified and not merely welded.

B. A Suggested Outline of Exercises for Practical Work in Zoology.

1. *Introductory: Exercises for Appreciation.* (Exercises 1-4.)

Purpose: To secure, early in the course and in an informal way, such a view of the subject-matter of biology and its relations to life that the student may have a real appreciation that will beget responsiveness.

Ex. 1. The Attractiveness of Nature. An informal study from memory, and a discussion, of the elements that tend to make nature beautiful and attractive to man.

Exercise 1, illustrated in detail.

Method: An exercise like this may properly take the form, first, of a conference of the class indoors, followed by an informal excursion to the nearest particularly attractive point of natural interest. Stereopticon, or other, pictures may be used very profitably to supplement, or even replace the excursion if the latter is not possible. The spontaneous expression of the pupil should be encouraged. The "Scientific Method" may properly be held in abeyance in these first exercises.

Topics:

1. *The Student's Memory of His Most Beautiful Natural View.* What kinds of things helped make it beautiful? What part did the form of land play in it? What part, water? What, clouds and "atmosphere"? What part did living objects, plant, or animal add? Why do you think such things seem beautiful to humans? Do you think this quality of appreciation in us can be cultivated and strengthened? Do you think it would, on the whole, add to the pleasure and value of life to strengthen it? Is it quite wise on our part to wait until we find all these elements of beauty in *one place* and in *extreme degree,* before we allow ourselves the pleasure and inspiration that come from appreciating them? What is the first quality we should try to cultivate in ourselves in order to get this pleasure? What next?

2. *The Special Contribution of Living Objects to Nature's Attractiveness.*

As you think of the beauty of the earth, what is added to it by plants? In what ways do animals add to it? Mention what seem to you now the chief beauties and interest of plants; of animals. Supplement with appreciative literature, and with pictures in which plants and animals are attractively represented.

* * *

Ex. 2. The Attractive Natural Points, Locally. A visit, a report, and a discussion of the most beautiful natural conditions in reach of the class, which may make a concrete test of the general conclusions in exercise 1 concerning the beauties of nature.

Ex. 3. The Pupils' Present Knowledge of Plants: A summing up of the knowledge of the class respecting plants, their characteristics, their value to animals and to men, their place in human industry and business.

Ex. 4. The Pupils' Present Knowledge of Animals. A similar inventory of their appreciation of animal values and relations.

II. *Introducing to the Library and the Field.* (Exercises 5-9).

Purpose: To acquaint the student with the books he will use, to teach him how to use them, to enable him to go willingly and with intelligence to the "field" in search for real problems and real solutions.

Ex. 5. A Library Exercise. Examination of available books, the making of a selected, classified list of a limited number, together with some broad estimate of the characteristics of at least a few of them. Discussion in class.

Ex. 6. A Preliminary Survey of the Territory. Examination by each student of a selected territory, with notes, and a map showing its general character. Reports. A list of questions suggested to the student by the study.

Ex. 7. A Special Survey of a Limited Territory. A general study, and report on the study, of *all* the observed animal life of a small area selected by the student. A list of the pupil's questions arising out of the study.

Ex. 8. A Collecting Excursion. The collecting and keeping in good condition of all animals captured on a special excursion; with notes about all animals found. List of questions for further study.

Ex. 9. Rough Identification of Animals Collected. Use of pictures, descriptions, and simplest possible keys, etc., to locate in a general way, the animals collected. This exercise may be extended, with profit, over several periods.

III. *Introducing to the Laboratory and Microscope.* (Exercises 10-13.)

Purpose: To acquaint the student with the general nature of work in the laboratory; to introduce him to the most remarkable instrument which we have to aid us in such studies; to enable him to get a mastery of the elementary use of the low power of the microscope. This series should be reduced to one or two exercises unless each student, or pair of students, has access to an instrument.

Ex. 10. The Construction of the Microscope. To get the main facts about the microscope, to suggest the uses of the parts, to show how structure and function are related.

Ex. 11. Securing Illumination. Theoretical and practical.

Ex. 12. Securing Focus. Theoretical and practical.

Ex. 13. Discovering the Effects of the Microscope on the Appearance of Objects.

IV. *Calendar Studies.*

Purpose: To bring the student into contact with some aspect of animal life in its successive relations through the year and thus encourage a sustained interest in some worth-while topic; to introduce the student to the seasonal rhythm of life and its meaning.

Method: These topics, preferably a different one for each pupil, should be selected early in the season, and should represent if possible some real interest of the student. There should be:

(1) A clear statement of the topic of study.

(2) An outline of the various methods of observation used.

(3) A statement of the results of the observations.

(4) Interesting or important conclusions based on the observations.

(5) A report of any studies by other people on the same subject, as contained in the literature, and a comparison of such with the pupil's results.

Suggested Topics:

1. Any exercises on the life history of animals. (See Exercises 95-107.)

2. Some of the economic studies. (Exercises 34-54.)

3. Record of the behavior of any common species of wild animals through the varying conditions of the year.

4. The effect of the seasons on any of the great vital functions of animals—as reproduction, general activity, securing food, etc.

5. Actual observable animal inhabitants of a given area of favorable territory throughout the year. (Statistical and descriptive.)

6. An account of the changes of the bird or other wild life of the community during the year.

7. Certain questions of variation, heredity, natural selection, etc. (See also Exercises 119-142.)

8. In general, any topic which suggests changes in the animal life day by day owing to climatic or other environmental conditions.

Ex. 14. Selection of Calendar Studies. A careful discussion, and selection by each student, of some calendar topic. The elements to be considered in such selection. Discussion of the general method of attack.

V. *The Laboratory Method; and an Inductive Study of the Chief Differences between Inorganisms and Organisms, Plants and Animals.* (Exercises 15-18.)

Purpose: To use a few familiar objects to introduce the pupil to the scientific method and to get before him, free from new and puzzling knowledge, the steps that must be followed in order to reach right conclusions; to give him practice in taking these steps; and to enable him to get for himself a definition of inorganic and organic, plant and animal.

Ex. 15. Sand. Pebbles. Crystals. Observe, record, and compare the really *observable* characteristics of these.

Ex. 16. Shells. Characteristics. Distinctive features; compare with sand, pebbles, and crystals.

Ex. 17. Plants. Study as above. Limit record to student's actual observations.

Ex. 18. Animals. Study as above. General conclusions. What are, after all, the *observable* distinctions between these five classes of objects?

VI. *The Study of a Representative Animal.* (Exercises 19-29.)

Purpose: The purpose of this series of exercises is to guide the student in forming the habit and ideal of accurate observation and in making a clear and exact record of observations; to cause him to study with some care and in some detail the relations of one type of animal to its natural environment; to allow him to discover the work which it is capable of doing and its chief adjustments to its manner of living, and to appreciate the complexity of the organization of the animal whereby it is enabled to do the work necessary for satisfactory living. (It is assumed in the following exercises that the grasshopper will be the most generally suitable animal.)

Ex. 19. Representative Animal: Introductory. A discussion of all the important things that enter into the determination of what will be a suitable animal. Select in the light of this discussion.

Ex. 20. Haunts and Habits of Life. A general study, in the field, of the place of living, general and special; kind of food used; relation to one another, and the like. Follow by reports and discussions in class.

Ex. 21. Its Chief Activities. A study of its powers—just what it can do: as motions, locomotion of various types, etc. A close study and analysis of the differences between these modes of action; and of the purposes of them.

Ex. 22. The External Organs and Their Relation to the Kinds of Activity. A tabular display of the relation between the structures and their functions.

Ex. 23. Sensitiveness. An observational and experimental study of the evidences of sensitiveness, the special kinds of sensitiveness, the location of the sense organs, the nature of the responses, etc.

Ex. 24. Sensitiveness (continued). Tabular display of senses, organs, stimuli, etc.

Ex. 25. The General Plan. The symmetry of the animal. What elements enter into symmetry?

Ex. 26. The General Plan (continued). Comparison of the axes. The meaning of dorsal and ventral, anterior and posterior, right and left; and the location of the various organs in relation to these regions, and the reasons therefor.

Ex. 27. General Plan: The Regions of the Body. A study of the form and function and relations of the three regions: head, thorax, and abdomen.

Ex. 28. Special Organs of the Three Chief Regions. A tabular display of all the organs related to each of the regions; their form, position, and functions, with drawings of them.

Ex. 29. Review of Representative Animal. Questions to unify the results of the study, and to apply the proper descriptive names to the organs.

VII. *Comparative Work in the Phylum to which the Representative Animal Belongs.* (*Arthropoda.*) (Exercises 30-33.)

Purpose: To cause the student to compare other slightly known animals with the grasshopper, and thus further emphasize his picture of the latter; to enable him to realize that his knowledge of animals in general is not exact; to give him a better conception of the group of insects and of its principal orders.

Ex. 30. *Off-hand Comparison of Some Familiar Animals with the Grasshopper.* Enumerate from memory the main points of likeness and unlikeness between ten or fifteen known animals and the representative animal.

Ex. 31. Identification of Insects. Each student should identify a few of the common insects by means of keys, figures, knowledge of their common names, etc. Location of a few less known forms in their proper Orders.

Ex. 32. Comparison of Insects. A tabular comparison of a representative insect from several of the Orders as to habitat, mouth parts, wings, form of body, metamorphosis, larval habits, etc. (Field and library). Definition of chief insect Orders.

Ex. 33. Comparison of Orthoptera (Tabular). A table bringing together, with some exactness and from any source of information open to the student, the points of likenesses and unlikenesses of grasshopper and other orthoptera—as the cricket, katydid, cockroach, walking-stick, etc.

Comparison of Orthoptera (Illustrative Table)

Characteristics	Cricket	Katydid	Cockroach	Pupil's Selection	Grasshopper
Habitat and habits					
Coloration and protective devices					
Body: Shape					
Body: Regions					
Body: Proportions					
Body: Segments					
Thoracic Appendages: Legs					
Thoracic Appendages: Wings					
Kinds of locomotion					
Mouth-parts					
Antennae					
Eyes					
Economic Importance					

In what respects do all these animals agree?

VIII. *Economic Studies.* (Exercises 34-55.)

Purpose: To make a practical application of zoölogical studies to human welfare and thus to strengthen the hold of zoölogy on the pupil through its human interest; to give knowledge that may be of direct practical utility; to reveal to the student the sources of our information of economic zoölogy, and to acquaint him with the work of our state and national bureaus and laboratories.

Method: All of these studies call for (1) actual observations by the pupil in the field; (2) inquiries of local experts—as farm-

ers, stockmen, gardeners, orchardists, etc.; and (3) references to the libraries. In each case the general facts of advantage or disadvantage, the facts relating to the care of or protection against, and the zoölogical place, should be brought out in such a way as to bind together the scientific and the practical aspects of the problem. Unless there is abundance of time, only those studies should be undertaken in which the student can reasonably hope to get, promptly, enough facts to reward his search. Further emphasis may be given to this matter by coördinating it with the study of the groups through the year. Some teachers prefer to do the economic work in the latter way solely.

Ex. 34. Economic Studies: Introduction. Finding out and utilizing all the student's present knowledge of economic values of animals. Enumeration and systematic classification of these values.

Ex. 35. Domesticated Animals. The main facts.

Ex. 36. Comparison of Domesticated Animals. (Tabular.)

Ex. 37. Pests of House and Barn. The main facts.

Ex. 38. Comparison of Household Pests. (Tabular.)

Ex. 39. Animals Producing Disease. The main facts.

Ex. 40. Comparison of Disease-Producing Animals. (Tabular.)

Ex. 41. Animals of the Garden. Main Facts. (Suitable for calendar study.)

Ex. 42. Comparison of Animals of Garden. (Tabular.)

Ex. 43. Animals of the Orchard. Main facts. (Suitable for calendar study.)

Ex. 44. Comparison of Animals of the Orchard. (Tabular.)

Ex. 45. Animals in Relation to Field Crops. (Suitable for calendar study.)

Ex. 46. Comparison of Animals Affecting Field Crops. (Tabular.)

Ex. 47. Pests of Stored Seeds, Fruits, and Grains. Main facts.

Ex. 48. Pests of Shade and Forest Trees. (Suitable for calendar study.)

Ex. 49. Comparison of Animals Destructive of Trees. (Tabular.)

Ex. 50. The Food-Yielding Animals. Main facts.

Ex. 51. The Animals Yielding Clothing to Man. Main facts.

Ex. 52. Comparison of Animals Furnishing Clothing. (Tabular.)

Ex. 53. Pets. A general study of the problem; the special types that have been so used; a detailed study by each student of some pet species, and its history.

Ex. 54. Animal Industries. A study of the organized human industries based on animal life. Some of the facts, with the zoological foundations for them.

Ex. 55. Comparison of Animal Industries (Tabular), as to human importance, geographical distribution, etc.

IX. *Studies of the Essentials of Living Matter.* (Exercises 56-57.)

Purpose: To enable the student better to get a notion of the machinery on which life depends, and of the real size, shapes, appearance, and powers of the cells, which are conveniently thought of as units of living matter.

Method: Demonstrations and studies of stained and unstained cells under the compound microscope, together with a study and comparison of all the figures of cells and tissues that can be found.

Ex. 56. Study of Single Cells. Microscopic study of cells. whole and in sections, showing characteristic parts. Dividing cells.

Ex. 57. Study of Cells in Union. Tissues. Demonstration and discussion of some representative tissues.

X. *Study of Types Illustrating the Evolutionary Series.* (Exercises 58-94.)

Purpose: To give the student a systematic view of the animal kingdom which can be had in no other way than through a progressive study of some representatives of the more important phyla; to enable him to realize the relation of increasing complexity of structure to increased efficiency of functioning, as one passes from the lower to the higher; to heighten his sense of the unity of animal life; to enable him to expand the type of the phylum by comparing other members of the phylum with it.

Method: In all the studies of this series it will be understood that physiology, morphology, and ecology will be mingled. It is not the purpose to give mastery of many details of structure, but rather to enable the student to realize the animal as a living machine with certain necessary adjustments to make and certain structure to make them with. There is no purpose of making a sharp analysis of the work, into morphology, ecology, and physiology.

Ex. 58. Introductory Examination of Cultures for Protozoa.

Ex. 59. Paramecium. Activities and form.

Ex. 60. Comparison of Various Protozoa. (Tabular: laboratory and library.)

Ex. 61. Sponges.

Ex. 62. The Simple Metazoa: Hydra.

Ex. 63. Hydra (continued).

Ex. 64. Coelenterata Compared. (Tabular.)

Ex. 65. The Simple Metazoa: Flatworms.

Ex. 66. Comparison of Parasitic Worms. (Tabular: library.)

Ex. 67. The Starfish.

Ex. 68. Comparison of Echinoderms. (Tabular.)

Ex. 69. The Earthworm: Habits and Powers; Economic Values.

Ex. 70. The Earthworm: Form and External Structure.

Ex. 71. The Earthworm: Internal Functions and Organs.

Ex. 72. Comparison of Segmented Worms. (Tabular.)

Ex. 73. A Clam (or Snail).

Ex. 74. Comparison of Mollusks. (Tabular.)

Ex. 75. A Fish: Habits and General Form.

Ex. 76. Fish: Activities and Powers; Special External Structures.

Ex. 77. Comparison of Fishes. (Tabular.)

Ex. 78. The Frog: Habitat and Habits; Activities in Laboratory.

Ex. 79. The Frog: General Form, Structure, and Development.

Ex. 80. The Frog: Skin, muscles, visceral organs—structure and functions.

Ex. 81. Comparison of Amphibia. (Tabular.)

Ex. 82. Reptiles: Study of General Characteristics. Field and library work.

Ex. 83. Comparison of Reptiles. (Tabular.)

Ex. 84. Birds: Varieties, Habitats, Noteworthy Habits.

Ex. 85. Birds: Other Activities and Powers.

Ex. 86. Birds: General External Form and Structure.

Ex. 87. Comparison of Birds. (Tabular.)

Ex. 88. Mammals: Introduction. General characteristics; varieties.

Ex. 89. Mammals: Field and Laboratory Work. Habits, powers, distinctive structure.

Ex. 90. Man as a Mammal. General Animal Habits and Activities.

Ex. 91. Man as a Mammal. Form of body; structure of internal organs.

Ex. 92. Comparison of Mammals. (Tabular.)

Ex. 93. Comparison of Vertebrates. (Tabular.)

Ex. 94. Comparison of Animals. (Tabular.)

XI. *Studies in the Life History of Animals.* (Exercises 95-107.)

Purpose: To enable the student to realize the simple way in which organisms start life and the steps whereby they reach maturity; to make clear the meaning of the life-cycle; to enable him to realize something of the meaning of reproduction and development among human beings.

Method: The time available will not allow each pupil to study even casually all the exercises in this section. It is suggested rather that all shall study Exercises 95-97, and that others chosen shall be divided among the students. Reports of all those individual studies should be made to the class, and all members should make the tabular comparison. These subjects are also suited to be calendar studies.

Ex. 95. Reproduction in Lower Forms: Protozoa, Hydra, etc.

Ex. 96. Reproduction in Higher Forms: Frog, Bird, etc.

Ex. 97. Reproduction in Mammals, including Man.

Ex. 98. Life History of Animals: Sea Urchin (Early Stages).

Ex. 99. Life History of Snail. Eggs, fertilization, development.

Ex. 100. Life History of Mosquito. Egg laying, fertilization, metamorphosis, etc.

Ex. 101. Life History of Blow Fly.

Ex. 102. Life History of Butterfly (or Moth).

Ex. 103. Life History of Potato Beetle.

Ex. 104. Life History of Spiders.

Ex. 105. Life History of Frogs or Toads.

Ex. 106. Early Life History of the Chick.

Ex. 107. Comparison of Life Histories. (Tabular.)

XII. *Studies in the Life Relations of Animals.* (Exercises 108-118.)

Purpose: To enable the student to see at first-hand how living objects are adjusted to some of the chief features of their environment; to discover what the really vital relations are; and to give him a better practical foundation for understanding what is found in the books on the subject.

Method: The student should combine the field, laboratory, and the library in these studies. A series of representative animals should be chosen, and their relation to the various environmental factors observed and recorded. Portions of this work may be done in connection with the study of the typical animals suggested in section X.

Ex. 108. Introductory. An enumeration and classification of the influential conditions of life with which the students are already somewhat familiar; fundamental and secondary conditions.

Ex. 109. Food and the Food-Relation. Organs for food capture; senses involved therein; choice of food; storing of food, etc.

Ex. 110. Relations to Moisture and Drouth. Adaptations to life in water, in moist places, in drouth, etc.; and to the use and retention of moisture internally.

Ex. 111. Relation to Temperature. Sense of temperature; bodily heat; special adaptations to changing temperature.

Ex. 112. Relation to Light. Sensitiveness to light; light and darkness lovers; perception and influence of color; seeing objects; eyes.

Ex. 113. Relation to Gravity and to the Density of the Medium. Gravity in relation to the normal position of animals; form of the body in relation to gravity; specific gravity in animals in relation to the medium in which they move. Effects of these things on animal organization.

Ex. 114. Relation to Sound. Nature of sound and the process of hearing in various grades of animals. Points of uniformity and of difference in the sound-receiving organs.

Ex. 115. Relation to Offspring. Various ways and degrees of care of offspring. The meaning of it in evolution.

Ex. 116. Relation to other Members of Same Species. Relations of mates; voluntary association, etc.

Ex. 117. Relations of Animals of Different Species: helpful, hurtful, and indifferent.

Ex. 118. Relations to Plants. Plant-eating animals; plant homes for animals; insects, and flowers, etc.

XIII. *Studies Relating to Variation, Heredity, and Evolution.*

Purpose: To introduce the student systematically to one of the most interesting of the modern aspects of the subject, and to give him a foundation in his own observations by means of which he may the better appreciate the literature dealing with it.

Method: Direct observations, supplemented by reference work.

Ex. 119. Study of Variations in Man. Kinds and amounts

of variations found among humans; that found in one family, etc.

Ex. 120. Variations in Poultry. Quality and quantity of variations within a breed; among breeds; sources of variations.

Ex. 121. Comparison of Varieties of Domestic Fowl. (Tabular.)

Ex. 122. Variation in Wild Species.

Ex. 123. Inheritance in Man. A study of the kinds of things that are inherited.

Ex. 124. Inheritance in Domestic Animals. Observed facts of.

Ex. 125. Inheritance in Wild Species. Comparison of inherited and acquired qualities.

Ex. 126. Rate of Multiplication in Animals. Possible increase; actual increase.

Ex. 127. Rate of Multiplication. Inorganic forces that keep down population; organic enemies; cite own observations.

Ex. 128. Adaptation. Effects of cross-breeding and human selection of animals; effects of natural forces on animals in the long run.

Ex. 129. Adaptation among Humans. Through inheritance (eugenics); through environment (euthenics).

XIV. *Studies of Certain Interesting and Extraordinary Adaptations among Animals.*

Purpose: To introduce the student in a systematic way to some of the more striking and spectacular facts of animal life; to add to the general interest and appreciation of the child in the animal kingdom; to suggest subjects for popular interest and reading after the course is finished.

Method: A large part of this work will necessarily be library work, and yet in each exercise the student should be urged to record the main facts of his own knowledge and observation first. A few of them lend themselves to experiment and measurement. It is probable that an increase of general interest could be secured in most classes by assigning these subjects at intervals during the course rather than by reserving them all for the end of it.

Ex. 130. Beauty among Animals. Examples of; the elements that contribute to beauty in different species.

Ex. 131. Size of Animals. Range of size within a species; among different species. Facts concerning peculiarly large and peculiarly small types.

Ex. 132. Strength in Animals. Methods of testing. Record of some results of testing and of reading.

Ex. 133. Rate of Motion. Measurements; records; interpretation in respect to general habits and conditions of life.

Ex. 134. Weapons of Animals. Study of the kinds, position, degree of development, manner and purpose of using, etc.

Ex. 135. Migrations. Local studies and references; times of year, direction, causes of, manner of, etc.

Ex. 136. Mating Habits of Animals. Differences between males and females, in structure and disposition, and the reasons therefore; courtship; types of mating.

Ex. 137. Home-Making among Animals. Types and purposes of homes; careful study of some particular types.

Ex. 138. Industries of Animals. Animals that play or work spontaneously; nature and value of these activities.

Ex. 139. Coöperation among Animals. Observed and recorded instances of animals of the same species working together in a coöperative way to accomplish results; of different species.

Ex. 140. Community Life. The degree of closeness of the social life of the members of some familiar species of animals; of foreign species of animals.

Ex. 141. Parasitism. The facts in the life history of at least one or two parasites. The general conditions and results of parasitism. A table of parasites, their hosts, the diseases they produce, and the phylum to which the parasite belongs.

Ex. 142. States of Activity and Rest. Relation of activity and rest in man and other known animals. Fatigue, rest, sleep, restoration; their physiology.

SETTING OF PORTLAND CEMENT.

The change in cement from slow to quick setting is due to the presence of alkali carbonates, which have an accelerating influence upon the setting process. In one case the addition of only 0.01 per cent of sodium carbonate reduced the time of setting from 6.5 hours to 20 minutes. Varying amounts of calcium sulphate, on the other hand, retard the process of setting.

THE YELLOW BUTTERFLY WEED.

By Willard N. Clute.

Anyone who lives near a stretch of sterile soil is likely to be acquainted with the butterfly weed or pleurisy root (*Asclepias tuberosa*). It seems especially fitted to endure the drouth conditions of sand barrens and clayey hillsides and in such situations its flat-topped umbels of orange-red flowers unobscured by the sparse vegetation inhabiting such places, makes it one of the most conspicuous of plants for some weeks following midsummer.

I have followed the books in calling the flowers orange-red, though this term is far from being adequate. With this, as with many another common species, its abundance and conspicuousness made it easily distinguished by the early botanists who were, in consequence, insufficiently impressed with the necessity for describing the flowers minutely and subsequent manual makers, most of whom have been more familiar with the appearance of the plants in the herbarium than in the field have simply copied the mistakes of their predecessors. An absolutely accurate description of the flowers is probably not to be found in the books reputed to be the arbiters of such matters. In one feature, however, all agree: the hoods are, indeed, "deep bright orange." But the hoods are only part of the flower; exactly half the flower, in fact, when we are discussing color, for the reflexed petals which about equal the divisions of the corona in size are themselves as bright and fully as effective in giving conspicuousness to the flower cluster. These latter parts the books dismiss with scant ceremony; in fact, one of our most authoritative manuals does not even mention them. Those which do are almost as bad for they describe them variously as greenish, greenish orange, or purplish orange, when in reality the average plant has orange-red petals that are frequently more highly colored than the hood itself. In the bud the edges of the petals are frequently deep red and while the outer surface may at this time be greenish, the inner surface has more of yellow in it than either. In the open flower the outside of the petal is often deep red. There is, to be sure, considerable diversity in the coloration of individual specimens and it may be possible that some of the flower clusters that in the distance blend into an unattractive brick-red may have more or less green in the petals. In any event, these are not the ones likely to be selected for cultivation or for inclusion in a bouquet of field flowers. By a little careful selection it is possi-

ble to secure flowers that are nearly pure red though far behind the cardinal flower or bee balm in the quality of color. Variations in the direction of yellow are also known as might be expected in flowers in which both colors are due to varying amounts of the same pigment. In the yellowish specimens, however, there is practically always sufficient red present to give the flowers a tawny hue and it was something of a surprise, last year, to come upon a plant with clear lemon-yellow flowers without trace of red or orange. This plant, removed to my garden has thrown up numerous stems which during the first half of July were loaded with flowers. Other plants of the same kind are likely to be discovered in any considerable area in which the plant grows, though they are scarcely likely to become common. To facilitate mention of the plant it seems desirable that a form name be given it and I therefore characterize it as

ASCLEPIAS TUBEROSA f. LUTA.

Flowers clear lemon-yellow the reflexed petals tinged on the exterior with orange; otherwise like the type.

The form, *lutea,* is comparable to the white-flowered and white-berried forms found in many species though it probably represents a transition stage midway between flowers with the absence of pigment and those having an abundance of it. It is another illustration of the well-known rule that red flowered forms may be expected to have yellow varieties. It is noticeable that yellow flowers rarely produce white or albino forms, though red and black colors are often accompanied by yellow specimens.—*American Botanist.*

WIRELESS DISTRESS CALLS NOT TO GO UNHEARD.

One of the most noteworthy steps taken during the International Radio-Telegraphic Conference which opened in London June 4 and closed July 5 is the laying down of a practical rule for attendance on the wireless apparatus on shipboard. It will be recalled that the "Titanic's" distress signals went unheard by vessels in the immediate vicinity because the single operator employed on those ships was off duty at the time. Under the Conference rule, a permanent watch is required on ships of the first class, which means that two operators must be employed, and on ships of the second class, employing only one operator, the receiving apparatus must be attended during the first ten minutes of each hour. In order to allow the operator to have his rest unbroken when off duty, this provision will probably mean that one of the crew trained to receive the distress signal, will be required to listen during the ten minutes beginning each hour.—*Scientific American Supplement.*

A COURSE IN CHEMISTRY FOR HOUSEHOLD SCIENCE STUDENTS.

By J. F. Snell,
Macdonald College, Ste. Anne de Bellevue, Quebec, Canada.

The following outline of a course in elementary chemistry, specially designed for students of household science, is taken from an address to the science department of the National Education Association. The course has been given to five successive classes in Macdonald College. The students in these classes have been of college age (from seventeen years up) but of very unequal preliminary education. The course has therefore been made simple, and the writer hopes it may be found suitable for high school girls. The aim has been to introduce only such principles as find immediate application in connection with household work, but to present these principles in a correct and truly scientific manner. The expository matter of the course has been in the hands of the last two Macdonald College classes in printed form, and it is hoped that the full course, including directions for the lecture table and laboratory experiments, will soon be regularly published in text-book form.

The definition of *chemical change* is first discussed. Such familiar illustrations as the charring of sugar, the souring of milk, and the fermentation of fruit are used, in addition to those commonly preferred on account of their theoretical simplicity—such actions as the burning of magnesium ribbon and the rusting of iron.

Decomposition is exemplified, not only by such chemically simple changes as the effect of heat on limestone, and the electrolysis of water, but also by the effect of heat on sugar or starch, and the putrefaction of meat or casein—reactions with which the term *decomposition* is commonly associated in the lay mind.

Following the conception of decomposition, the student is introduced to the ideas of *element* and *compound* and to chemical nomenclature reduced to its lowest terms—the signification of the suffixes "ide" and "ate." Chemical notation is utilized, but the student is not required to master it. Reactions are commonly expressed in words, as well as in symbols. The *atomic theory* is presented dogmatically and its relation to chemical notation pointed out.

Instead of next passing to a study of the elements and their binary compounds—as is commonly done in purely cultural

courses—we pass directly to the definitions of *acid, base,* and *salt.* Hydrogen and oxygen having been prepared incidentally to the introductory topics of the course, it is not difficult to show by laboratory experiments that the substances called *acids* have not only a sour taste and a characteristic effect on litmus, but also liberate hydrogen when treated with metals. The formation of *salts* in these reactions can be illustrated not only by evaporating the solutions, but also by a lecture experiment in which concentrated hydrochloric acid is treated with sodium, and the purified solid product tasted by the class.

It is also possible to establish by qualitative experiments that the typical *base,* caustic soda, contains the three elements, sodium, hydrogen, and oxygen. The insoluble bases and basic oxides are then introduced, and the effects of acids upon them illustrated and explained. The rusting of iron and the tarnish of other metals are accounted for as due to superficial oxidation, iron oxide scaling off and exposing new surface, while zinc and aluminium oxides are adherent, and serve to protect the metal from further corrosion. The various artificial protective coatings for iron are discussed, and the virtue of prompt polishing of stained household cutlery impressed. The effect of oxalic acid and salt of lemons (acid potassium oxalate) in removing rust stains from fabrics is also explained here.

The conception of *strong* and *weak* acids is next introduced by experiments showing that normal solutions of hydrochloric and sulphuric acids attack zinc more rapidly than do the equivalent solutions of formic and acetic acids. The principle having been illustrated, the student is asked to memorize a classification of the common acids and bases, according to strength.

A laboratory exercise follows, which not only serves as a review of this classification, but also affords practice in nomenclature, and introduces the conception of hydrolysis. A dozen soluble salts are given out with their common and chemical names. The students dissolve the salts and record for each the reaction to litmus, the name of the corresponding acid and base, and the relative strengths of these acids and bases. Reviewing the record they discover that in aqueous solution (1) the salts of strong acids with strong bases, *e. g.*, sodium chloride, are neutral; (2) the salts of strong acids with weak bases, *e. g.*, aluminium sulphate, are acid; (3) the salts of weak acids with strong bases, *e. g.*, sodium carbonate, are alkaline; and (4) that no salts of weak acids with weak bases have been given them. That the

water has acted upon the salts derived from either a weak acid or a weak base can be made clear—at least for the case of a weak acid—by an experiment with soap. Dissolved in alcohol, a good soap is neutral to the indicator, phenol phthalein. The addition of water to the alcoholic solution causes the pink coloration indicative of alkalies to appear. The water has liberated a certain amount of acid and base, and the latter being strong has affected the indicator.

Hydrolysis may be defined as such action of water on a molecule as results in the production of two or more new molecules. In the case of a salt the new molecules formed are an acid and a base. But the general principle of hydrolysis is illustrated in many other reactions of importance in the household, and particularly in the processes of digestion of the three great classes of food constituents, proteins, carbohydrates, and fats. Hence the prominence accorded to a phenomenon commonly ignored in elementary chemistry.

The interaction of two salts, with the production of a precipitate, is illustrated by the action of soap with hard water. The topics of temporary and permanent hardness of water, and the theory of water softening are now in order.

Ammonia comes next, and serves as a connecting link between the alkalies and the alcohols. For ammonium hydroxide is an alkali, and can be classed as a base, if we slightly modify the definition of base originally learned. And familiarity with the ammonium radical prepares the student to accept the radicals of the alcohols.

Incidentally, uses and abuses of "household ammonia" may be referred to—uses of the material and abuses of the name.

The current of thought now flows smoothly into the regions of organic chemistry. Alcohols are the hydroxides of radicals composed of carbon and hydrogen. Like alkalies, alcohols react with acids. The products of such action are water and esters. Fats are esters. Like salts, esters can be hydrolyzed. The hydrolysis of esters is accelerated by the removal of any product of the reaction. The presence of a strong base results in the immediate removal of the acid formed in the hydrolysis of an ester. Hence saponification is simply the hydrolysis of an ester in presence of a base. Therein lies the basis of soap-making.

The dissolving of fats in such liquids as benzine is contrasted with their behavior on shaking with water. The difference is that between solution and emulsification. Both these processes

are utilized in the cleaning of fabrics; the former in dry cleaning, the latter in laundry practice, where the marvelous emulsifying powers of soap solutions play a part of immense importance.

Fats, having been considered in the role of raw material for soap-making, and in that of dirt on fabrics, have now to be discussed as constituents of foods. Their presence in some foods is obvious. In others, such as oatmeal and nuts, it can be demonstrated by extracting the ground material with a solvent, filtering and evaporating. The use of benzine, rather than ether, as the solvent will be appreciated by girls of weak stomach.

Fat may also be extracted from the leanest meat, if water has first been removed from the tissues by kneading in strong alcohol. The proportions of fat in various foods is now discussed with the class, then the process of digestion and the energy or fuel value.

In studying the digestion of fats, which according to recent views is essentially a hydrolytic process, the student meets with an example of the effect of a ferment in accelerating hydrolysis. The same influence is later shown to be equally important in the digestion of carbohydrates and proteins, and is more readily demonstrated by laboratory experiments upon nutrients of these classes than upon the fats.

Following the fats, the carbohydrates are discussed. By placing solutions of typical sugars and polysaccharides in parchment dialyzers, surrounded by water, and allowing them to stand over to the next meeting of the class, the fact that only the sugars pass through membranes can be demonstrated. This explains the necessity of hydrolytic cleavage of the polysaccharides in digestion. The necessity for the hydrolysis of the disaccharides, cane sugar, malt sugar, and milk sugar, it has been my custom to leave unexplained.

The digestion of starch by saliva is, of course, easily demonstrated in the laboratory, and an invertase can be isolated from yeast and used to illustrate fermentative hydrolysis of cane sugar. Acid hydrolysis can also be readily demonstrated with cane sugar, starch, and filter paper. Incidentally to these experiments the student becomes familiar with the Fehling test for reducing sugars, and the iodine test for starch. The modification of the Fehling solution devised by Dr. Stanley Benedict (now of Cornell Medical College) I have found very convenient for laboratory use, as it is kept in a single bottle, and does not deteriorate.

Alcoholic fermentation and caramelization of sugars are topics of obvious interest to the housekeeper.

The treatment of the proteins, the most complex and therefore the most difficult class of nutrients, must now be faced. Their unique composition and functions must obviously be emphasized, and the wide divergence of properties among them must not be concealed. A few of the leading protein tests are learned by experiment upon isolated proteins, such as egg albumen, blood albumen, and casein, and are then applied to food materials, and also to the discrimination of silk and wool from cotton and linen. The digestion of proteins is illustrated by treatment of fibrin with pepsin in hydrochloric acid solution, and with trypsin in sodium bicarbonate.

To complete the discussion of foods, the composition of those of vegetable origin is contrasted with that of foods of animal origin. The leading exceptions to the general rule that vegetable foods are carbohydrate foods, and animal foods protein and fat foods, are recounted.

In the discussion of foods, fuel value has to be given prominence. Irving Fisher's mode of comparing fuel values and expressing the composition of foods recommends itself by its simplicity. It is of much greater value to know what percentage of the total fuel value of a food comes from protein than to know what per cent of the total weight is composed of protein.

Dietary Standards conclude the subject of foods.

The discussion of *combustion* I have allowed to follow that of foods, though it would be possible and might be advantageous to introduce it much earlier.

The course I have outlined occupies the time at the disposal of my class. Teachers having more time, or a better-prepared and better-graded class can easily expand the course upon the same principle of selecting the theoretical matter appropriate to the household applications of chemistry which they desire to bring to the attention of the class. Whatever work is undertaken, the habits of careful observation and logical deduction should be fostered. Any household science course which does not promote the scientific spirit is evidently misnamed.

PROBLEM DEPARTMENT.

By E. L. Brown,
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Readers of this magazine are invited to send solutions of the problems in which they are interested. Problems and solutions will be duly credited to their authors. Address all communications to E. L. Brown, 3435 Alcott Street, Denver, Colo.

Algebra.

303. *Proposed by Nelson L. Roray, Metuchen, N. J.*

If $\frac{y+z}{pb+qc} = \frac{z+x}{pc+qa} = \frac{x+y}{pa+qb}$,

show that $\frac{2(x+y+z)}{a+b+c} = \frac{(b+c)x+(c+a)y+(a+b)z}{bc+ca+ab}$.

(Hall and Knight's Higher Algebra, p. 11, ex. 11.)

I. *Solution by T. F. Leighton, Chicago, Ill., and M. H. Pearson, Montgomery, Ala.*

The sum of the antecedents being to the sum of the consequents as any antecedent to its consequent, we have

$$\frac{2(x+y+z)}{(p+q)(a+b+c)} = \frac{y+z}{pb+qc}$$

Multiplying the given ratios by a, b, c respectively we have

$$\frac{a(y+z)}{pab+qac} = \frac{b(z+x)}{pbc+qab} = \frac{c(x+y)}{pca+qbc}$$

$$\therefore \frac{a(y+z)+b(z+x)+c(x+y)}{(p+q)(bc+ca+ab)} = \frac{a(y+z)}{pab+qac} = \frac{y+z}{pb+qc}$$

$$\therefore \frac{2(x+y+z)}{(p+q)(a+b+c)} = \frac{a(y+z)+b(z+x)+c(x+y)}{(p+q)(bc+ca+ab)} = \frac{(b+c)x+(c+a)y+(a+b)z}{(p+q)(bc+ca+ab)}$$

II. *Solution by C. H. Stoutenburgh, Trenton, N. J.*

Using the first two, then the first and last equations, "solving" in each case for $\frac{p}{q}$ and equating the results:

$$\frac{a(y+z)-c(z+x)}{c(y+z)-b(z+x)} = \frac{b(y+z)-c(x+y)}{a(y+z)-b(x+y)}.$$

Clearing of fractions and collecting terms:

$(ab+ac)x+(ab+bc)y+(ac+bc)z=(b^2+c^2)x+(a^2+c^2)y+(a^2+b^2)z$.

Adding $bcx+acy+abz$ to both sides,

$(ab+bc+ca)x+(ab+bc+ca)y+(ab+bc+ca)z=(b^2+bc+c^2)x+(a^2+ac+c^2)y+(a^2+ab+b^2)z$.

Adding the 1st member of the equation to both sides

$2(ab+bc+ca)(x+y+z)=x[(b+c)^2+a(b+c)]+y[(a+c)^2+b(a+c)]+z[(a+b)^2+c(a+b)]$

That is, $2(ab+bc+ca)(x+y+z)=(a+b+c)[(b+c)x+(a+c)y+(a+b)z]$.

Whence $\frac{2(x+y+z)}{a+b+c} = \frac{x(b+c)+y(c+a)+z(a+b)}{ab+bc+ca}$.

304. *Selected.*

Divide a number a into two parts such that the product of the nth power of one and the mth power of the other shall be a maximum. (Solve without the use of calculus.)

Solution by F. Eugene Seymour, Trenton, N. J.

The following proof depends upon the theorum: The product of any number of positive quantities whose sum is constant is a maximum when those quantities are all equal.

Let the two parts be x and $a-x$. Then it is required to find what value of x makes $x^n \cdot (a-x)^m$ a maximum.

Let $L=x^n \cdot (a-x)^m$.

$$\therefore \frac{L}{n^n \cdot m^m} = \frac{x^n \cdot (a-x)^m}{n^n \cdot m^m} = \left(\frac{x}{n}\right)^n \cdot \left(\frac{a-x}{m}\right)^m.$$

Since n and m are constants evidently L will be a maximum when $L \div (n^n \cdot m^m)$ is a maximum.

Now $\left(\frac{x}{n}\right)^n \cdot \left(\frac{a-x}{m}\right)^m = \left(\frac{x}{n} \cdot \frac{x}{n} \cdot \frac{x}{n} \cdots\right)\left(\frac{a-x}{m} \cdot \frac{a-x}{m} \cdot \frac{a-x}{m} \cdot \cdots\right)$.

The sum of the factors in this last product is constant since there are n factors in the first part and m factors in the second part making the sum a.

Hence the produce (and therefore L) will be a maximum when these factors are all equal, that is when

$$\frac{x}{n} = \frac{a-x}{m}, \text{ or when } x = \frac{an}{m+n}.$$

Therefore $x^n \cdot (a-x)^m$ will be a maximum when

$$x = \frac{an}{m+n}.$$

299. *Proposed by Henry A. Levy, Houghton, Mich.*

Find the value of the undetermined coefficients in the expansion:

$$\frac{(4!)^3}{n^3(n+1)^3 \ldots (n+4)^3} = \frac{1}{n^3} - \frac{64}{(n+1)^3} + \frac{216}{(n+2)^3} - \frac{64}{(n+3)^3} + \frac{1}{(n+4)^3}$$
$$+ \frac{A}{n(n+1)\ldots(n+4)} + \frac{B}{n(n+1)\ldots(n+3)} - \frac{90}{n(n+1)(n+2)} + \frac{C}{n^2(n+1)^2\ldots(n+4)^2}$$
$$+ \frac{D}{n^2(n+1)^2\ldots(n+3)^2} + \frac{E}{n^2(n+1)^2(n+2)^2} + \frac{F}{n^2(n+1)^2} + \frac{G}{n^2(n+4)^2}.$$

Solution by E. B. Escott, Ann Arbor, Mich.

The expression is more symmetrical if n is replaced by $x-2$.

$$\frac{(4!)^3}{(x-2)^3(x-1)^3x^3(x+1)^3(x+2)^3} = \frac{1}{(x-2)^3} - \frac{64}{(x-1)^3} + \frac{216}{x^3} - \frac{64}{(x+1)^3} +$$
$$\frac{1}{(x+2)^3} + \frac{A}{(x-2)(x-1)x(x+1)(x+2)} + \frac{B}{(x-2)(x-1)x(x+1)}$$
$$- \frac{90}{(x-2)(x-1)x} + \frac{C}{(x-2)^2(x-1)^2x^2(x+1)^2(x+2)^2}$$
$$+ \frac{D}{(x-2)^2(x-1)^2x^2(x+1)^2} + \frac{E}{(x-2)^2(x-1)^2x^2} + \frac{F}{(x-2)^2(x-1)^2}$$
$$+ \frac{G}{(x-2)^2(x+2)^2} \qquad (1)$$

Transposing the first four terms on the right side to the left, combining these fractions into one and simplifying, we get

$$\frac{-90x^6+1620x^4-8730x^2+1290}{x(x^2-1)^2(x^2-4)^2} = \frac{A}{(x^2-4)(x^2-1)x} + \frac{B}{(x-2)(x^2-1)x} -$$
$$\frac{90}{(x-2)(x-1)x} + \frac{C}{(x^2-4)^2(x^2-1)^2x^2} + \frac{D}{(x-2)^2(x^2-1)^2x^2} +$$

$$\frac{E}{(x-2)^3(x-1)^3x^3}+\frac{F}{(x-2)^3(x-1)^3}+\frac{G}{(x^3-4)^3}. \qquad (2)$$

Also transposing the term $\frac{-90}{(x-2)(x-1)x}$ to the left side and combining, we have

$$\frac{270x^6+1350x^4-1350x^3-9270x^2+1080x+13680}{(x^3-4)^3(x^3-1)^3x} =$$

$$\frac{A}{(x^3-4)(x^3-1)x}+\ldots\ldots\ldots\ldots\ldots \qquad (3)$$

Multiplying both members by $x^3(x^3-1)^3(x^3-4)^3$ and putting $x=0$ we get

$$C+4D+4E=0. \qquad (4)$$

Multiplying both members by x^4 and then putting $x=\infty$ we get

$$B+F+G=270. \qquad (5)$$

Multiplying both members by $(x-1)^3$ and then putting $x=1$ we get

$$C+9D+36E+36F=5760. \qquad (6)$$

Multiplying by $(x+1)^3$ and putting $x=-1$ we get

$$C+D=-5760. \qquad (7)$$

Multiplying by $(x-2)^3$ and putting $x=2$ we get

$$C+16D+144E+576F+36G=-3600. \qquad (8)$$

Multiplying by $(x+2)^3$ and putting $x=-2$ we get

$$C+36G=3600. \qquad (9)$$

Multiplying by x^3 and putting $x=\infty$ we get

$$A+2B+6F=1350. \qquad (10)$$

By solving equations (4) to (10) we find the values of A, B, C, D, E, F, G.

Geometry.

305. *Proposed by F. Eugene Seymour, Trenton, N. J.*

Given the three distances from a point within an equilateral triangle to the vertices to construct the triangle.

I. *Solution by I. L. Winckler, Cleveland, Ohio.*

Let a, b, c, be the distances from the vertices A, B, C to O, the point within the equilateral triangle. Construct the triangle OAD with the sides OA, AD, DO equal respectively to a, b, c.

On DO construct an equilateral triangle DOC, C and A being on opposite sides of DO, and draw AC. On AC construct the equilateral triangle ACB so as to contain the point O. This is the required triangle.

Draw OB. $\triangle OBC = \triangle ADC$. For $AC = CB$, $OC = CD$, and $\angle ACD = \angle OCB$, each being equal to $60° - \angle OCA$. $\therefore OB = AD = b$.

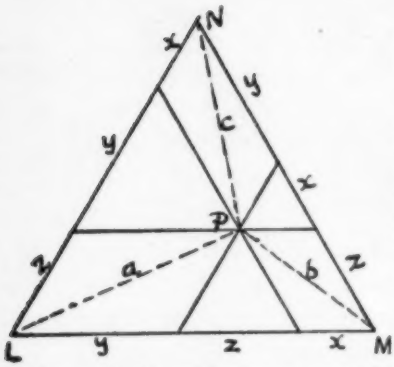
II. *Solution by Norman Anning, North Bend, B. C.*

Let a, b, c be the given distances and d the side of the required triangle. Construct the triangle ABC whose sides are a, b, c.

Describe equilateral triangles BCD, CAE, ABF all outward. The lines AD, BE and CF are equal in length and are concurrent at O, and the whole angle about O is divided into six equal parts.

Write x, y, z for AO, BO, CO. We have the equations

$$a^2=y^2+yz+z^2$$
$$b^2=x^2+xz+z^2,$$
$$c^2=x^2+xy+y^2.$$



Applying Ptolemy's theorem to the cyclic quadrilateral BDCO we find that OD = OB + OC = $y+z$.

$\therefore$ AD = $x + y + z = d$, the side of the required equilateral triangle. To prove this, construct the equilateral triangle LMN whose side is d. Divide the sides as shown in the figure and draw parallels. These will be concurrent at a point P such that

$PL^2=y^2+yz+z^2=a^2$ or $PL=a$.

Similarly PM = b and PN = c, and LMN is the required triangle.

Note: If the equilateral triangles BCD, CAE, ABF had been described all inward we would obtain a second solution of the more general problem: "Given the three distances from any point within, or without, an equilateral triangle to the vertices to construct the triangle."

306. *Proposed by Editor.*

If a cube and an octahedron have a common circumscribing sphere, prove that their surfaces are in the same ratio as their volumes.

Solution by T. F. Leighton, Chicago, Ill.

Denote by x an edge of the octahedron. The octahedron is the sum of eight pyramids having common vertex at the center of the sphere; the bases of the pyramids are the faces of the octahedron. These faces have area, each, expressed by $\frac{x^2}{4}\sqrt{3}$, so that the surface of the octahedron is $2x^2\sqrt{3}$, and its volume is $2x^2\sqrt{3}$ times one-third the common altitude of the pyramids, or $2x^2\sqrt{3}$ times $\frac{x}{3\sqrt{6}}$, or $\frac{1}{3}x^3\sqrt{2}$. The diagonal of the cube passes through the center of the sphere, and under the hypothesis equals $x\sqrt{2}$. If we denote by y the edge of the cube, $y\sqrt{3}$ is its diagonal, and $y\sqrt{3}=x\sqrt{2}$, or $y=2x/\sqrt{6}$. The surface of the cube is therefore $4x^2$, and its volume is $\frac{4x^3}{3\sqrt{6}}$.

$$\therefore \frac{S_o}{S_c} = \frac{2x^2\sqrt{3}}{4x^2} = \frac{\sqrt{3}}{2},$$

$$\text{and } \frac{V_o}{V_c} = \frac{\frac{1}{3}x^3\sqrt{2}}{\frac{4x^3}{3\sqrt{6}}} = \frac{\sqrt{3}}{2}.$$

$$\therefore \frac{S_o}{S_c} = \frac{V_o}{V_c}.$$

Trigonometry.

307. *Proposed by A. C. Smith, Denver, Colo.*

Show that $\cos 36^\circ \cos 72^\circ = \frac{1}{4}$.

I. *Solution by R. M. Mathews, Chicago, Ill.*

The equation $\cos 36^\circ \cos 72^\circ = \frac{1}{4}$ is of the form

$$\cos A \cdot \cos 2A = \frac{1}{4}.$$

Since $\cos 2A = 2\cos^2 A - 1$ this becomes

$$8\cos^3 A - 4\cos A - 1 = 0,$$

A cubic to be solved for $\cos A$.

Factoring, $(2\cos A+1)(4\cos^2 A - 2\cos A - 1) = 0$,

whence $\cos A = -\frac{1}{2}, \frac{1+\sqrt{5}}{4}, \frac{1-\sqrt{5}}{4}$.

When $\cos A = -\frac{1}{2}$, $A = 120°, 240°$;

$$\cos A = \frac{1+\sqrt{5}}{4} = .8090, \quad A = 36°, 324°;$$

$$\cos A = \frac{1-\sqrt{5}}{4} = -.3090, \quad A = 108°, 252°.$$

II. *Solution by Norman Anning, North Bend, B. C.*

$$\cos^2 36° - \cos^2 72° = \tfrac{1}{2}(2\cos^2 36 - 1 + 1 - 2\cos^2 72°)$$
$$= \tfrac{1}{2}(\cos 72° - \cos 144°)$$
$$= \tfrac{1}{2}(\cos 72° + \cos 36°)$$

Divide through by $\cos 36° + \cos 72°$ which is not zero since each is positive.

$$\therefore \cos 36° - \cos 72° = \tfrac{1}{2},$$
$$\cos 36° + \cos 108° = \tfrac{1}{2},$$
$$2\cos 72° \cos 36° = \tfrac{1}{2}.$$
$$\therefore \cos 36° \cos 72° = \tfrac{1}{4}.$$

III. *Solution by F. Eugene Seymour, Trenton, N. J.*

Let ABC be a $\triangle$ constructed containing the given angles, $A = 72°$, $C = 36°$, and $\therefore B = 72°$. Let CD be the altitude from C and AE the bisector of the $\angle A$. Let $AB = 2c$, $AC = BC = b$. $\therefore AE = CE = AB = 2c$, and $BE = b - 2c$.

$$\text{Cos } 72° = \frac{c}{b}; \quad \therefore 2\cos^2 36° - 1 = \frac{c}{b}, \text{ or } \cos 36° = \sqrt{\frac{b+c}{2b}}.$$

$$\therefore \cos 36° \cdot \cos 72° = \frac{c}{b}\sqrt{\frac{c+b}{2b}}.$$

But, since AE bisects the $\angle A$,

$$(b-2c) : 2c = 2c : b, \text{ whence } b = c(\sqrt{5}+1).$$

$$\therefore \cos 36° \cdot \cos 72° = \frac{c}{c(\sqrt{5}+1)}\sqrt{\frac{c(\sqrt{5}+2)}{2c(\sqrt{5}+1)}} = \tfrac{1}{4}.$$

IV. *Solution by the Proposer.*

Let AOE be diameter of circle O; AB, BC, CD sides of a regular inscribed decagon; BD, DE sides of a regular inscribed pentagon; CP a diameter intersecting BD in M and AB produced in L. Let $p = ED = DB$, and $d = AB = BC = CD$.

Let r = radius of circle. $BL = BO = r$ and M is mid-point of $LO = r + d$, since $LC = BC = d$.

$LA \cdot LB = LP \cdot LC$, or $r(r+d) = d(d+2r)$. $\therefore r^2 = d^2 + rd$. (1)

$BM^2 = BO^2 - OM^2$, or $(p/2)^2 = r^2 - \left(\frac{r+d}{2}\right)^2$. $\therefore p^2 = 3r^2 - 2rd - d^2$ (2)

From (1) and (2), $p^2 = r^2 + d^2$. (3)

$BD^2 = BO^2 + DO^2 - 2BO \cdot DO \cdot \cos BOD$, or $p^2 = 2r^2 - 2r^2 \cos 72°$. (4)

$BC^2 = BO^2 + CO^2 - 2BO \cdot CO \cdot \cos BOC$, or $d^2 = 2r^2 - 2r^2 \cos 36°$. (5)

From (3) and (4), $p^2 - d^2 = 2r^2(\cos 36° - \cos 72°)$ (6)

$\therefore$ from (3) and (6), $\cos 36°-\cos 72°=\frac{1}{2}$.
But $\cos 36°-\cos 72°=2 \sin 54° \sin 18°=2 \cos 36° \cos 72°$.
$\therefore$ $2 \cos 36° \cos 72°=\frac{1}{2}$,
or $\cos 36° \cos 72°=\frac{1}{4}$.

CREDIT FOR SOLUTIONS RECEIVED.

303. Byron Cosby, A. M. Harding, Philip Fitch, T. F. Leighton, D. E. MacCormick, R. M. Mathews, A. L. McCarty, M. H. Pearson, F. Eugene Seymour, C. H. Stoutenburgh, I. L. Winckler. (11)
304. E. Eugene Seymour, C. H. Stoutenburgh. (2)
305. Norman Anning, M. H. Pearson, C. H. Stoutenburgh, F. Eugene Seymour, I. L. Winckler. (5)
306. T. F. Leighton, R. M. Mathews, M. H. Pearson, Kenneth Reynolds, C. H. Stoutenburgh, I. L. Winckler. (6)
307. Norman Anning, A. M. Harding, E. A. Pollard Jones, T. F. Leighton, R. M. Mathews (2 solutions), A. L. McCarty, M. H. Pearson, F. Eugene Seymour, A. C. Smith, C. H. Stoutenburgh, I. L. Winckler. (12)

Total number of solutions, 36.

PROBLEMS FOR SOLUTION.

Algebra.

318. *Proposed by Elmer Schuyler, Brooklyn, N. Y.*
A man was born in the nineteenth century.
He was x years of age in year x^2.
Find his age in the year 1875.

319. *Proposed by E. B. Escott, Ann Arbor, Mich.*

Solve: $x^2-(y-z)^2=a.$ (1)
$y^2-(z-x)^2=b.$ (2)
$z^2-(x-y)^2=c.$ (3)

Geometry.

320. *Proposed by Elmer Schuyler, Brooklyn, N. Y.*
The distance between the centers of two circles is 12. The length of the common external tangent is 15 and that of the common internal tangent is 10. Required the radii of the circles.

321. *Proposed by L. L. Harding, Suffield, Conn.*
The arc of a circle is 350 feet long; the distance from its mid-point to its chord is four inches. What is the length of the chord?

322. *Proposed by H. E. Trefethen, Waterville, Me.*
The centers of two circles are A and B. Draw their common tangents with the straight edge only.

NEARLY THREE FOURTHS OF A MILLION MINERS.

The number of miners engaged in bituminous and lignite mining in 1911 was 549,750 and those in anthracite mining, 172,585, a total of 722,335. The average production per man was 738 tons for the year in the bituminous and lignite mines and 524 tons in the anthracite mines. In 1910 the corresponding averages were 751 and 498 tons.

SCIENCE QUESTIONS.

By Franklin T. Jones,
University School, Cleveland, Ohio.

Readers of School Science and Mathematics *are invited to propose questions for solution—scientific or pedagogical—and to answer questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, University School, Cleveland, Ohio.*

Questions and Problems for Solution.

97. *Proposed by C. E. Guffin, Wellman-Seaver-Morgan, Engineering Co., Cleveland, Ohio.* (This is an *actual* problem.)

A load is attached to the axle of a sheave and the whole suspended by means of a rope passed around the sheave so as to divide the load on the ropes into two parts. Call that part of the rope on one side of the sheave A and that on the other side B.

The suspended load amounts to 40,000 lbs. With the end of the rope B fixed, what will be the pull at A necessary to lift the load if friction reduces the efficiency to 97.5%. What will be the pull at B?

[The following lists of questions are from the University of Melbourne. These particular questions are entitled Senior Public Examination.]

Please answer serially numbered questions.

Chemistry.

1. Describe fully one method by which the exact composition of water has been determined.

What are the respective advantages of adopting $H = 1$ or $O = 16$ as a standard for the atomic weights of the elements?

98. One volume of acetone will dissolve 25 volumes of acetylene at 15°C. Assuming the validity of Henry's law, what weight of calcium carbide will be required to generate sufficient acetylene to saturate one litre of acetone at 15°C. under a pressure of 9 atmospheres.

3. How would you prepare pure calcium carbonate from an impure magnesian limestone?

4. Write an essay on *water of crystallization.*

5. Describe what happens when—

(*a*) nitrogen is passed over red-hot magnesium;

(*b*) a mixture of calcium sulphate and charcoal are heated to redness in a closed crucible;

(*c*) dry chlorine is passed over a heated mixture of carbon and alumina.

What is the action of water on each product?

6. How does starch occur in nature? Describe its purification and conversion into glucose.

Physics.

1. Give a full description, experimental and theoretical, of the method employed by Regnault for determining the expansion of mercury.

2. The Torricellian vacuum of a barometer can be put in communication, by means of taps, with the upper parts of two closed vessels; one of these contains only water and its vapor, the other alcohol and its vapor. Both taps are opened when the barometer is recording atmospheric pressure, and afterwards left open.

Describe the sequence of phenomena, inside the barometer tube and the other two vessels, and account for it as far as you can.

99. A calorimeter weighs 65 grammes empty and 327.5 grammes when three-fourths filled with water at room temperature 14.9°C. Steam is blown in till the temperature becomes 25.1° C., an operation which lasts 1 minute; the temperature falls 0.6° in the next 3 minutes. The calorimeter and contents now weigh 332 grammes. Taking the specific heat of the material of the calorimeter as 0.1, find the Latent Heat of steam.

4. Describe a practical method of determining the magnetic declination.

5. Describe the construction of a Leyden Jar, give some account of its uses, and obtain an expression for its capacity in terms of its dimensions.

6. Describe the construction and mode of use of the Tangent Galvanometer.

It is desired to construct a tangent galvanometer, such that a current of 1 deciampere in its coil shall deflect the needle through 45° at a place where H = 0.22; the coil is to contain 25 turns of wire. Find the proper value for its mean radius.

7. Describe one practical method of measuring the velocity of Light.

8. Explain the terms Focus, Principal Focus, Conjugate Foci, Focal Length.

Obtain the general relation between the focal length of a spherical mirror and the distances from the mirror to a bright point on its principal axis and to the image of the point.

9. What do you understand by the terms Musical Interval, Octave, Major Third?

Give a full account of the musical intervals of the diatonic scale.

10. The lower end of a thin-walled tube, 3.5 cm. in diameter, is immersed in water; when the upper end is 31.7 cm. above the water, the tube gives its best resonance to a fork vibrating 258 times per second. Find the velocity of sound in the air inside the tube.

Solutions and Answers.

82b. A body whose specific gravity is 7.6 weighs 54.6 gm. What will it weigh in oil whose specific gravity is 0.9?

Correction by Jno. A. Hodge, Sumner High School, Kansas City, Kan.

Volume body $= \frac{54.6}{7.6} = 7.18 c.c.$

Weight oil displaced $= 7.18 \times .9 = 6.46 gm.$

Weight body in oil $= 54.6 - 6.46 = 48.14 gm.$ *Ans.*

96. *Proposed by C. A. Perrigo, Dodge, Neb.*

The record baseball throw is 400 feet. Find the initial velocity.

Solution by Jno. A. Hodge, Sumner High School, Kansas City, Kan.

Since there is nothing said as to the angle at which the ball is thrown we may consider a particular case and the general one.

I. Ball thrown vertically upward.

$v = \sqrt{2gs} = \sqrt{64.4 \times 400} = \sqrt{25760} = 160.5$ ft. per sec.

II. Ball thrown at the angle θ.

Let v = initial velocity, then $x = v \cos \theta . t$ where x is the horizontal distance the ball is thrown, t being the time that has elapsed after starting. Also vertical height, $y = v \sin \theta \cdot t - \frac{1}{2} g t^2$.

Eliminating t from the equations:

$$x = v \cos \theta \cdot t$$

$$y = v \sin \theta \cdot t - \tfrac{1}{2} g t^2$$

we get $y=x \tan\theta - \frac{gx^2}{2v^2\cos^2\theta}$ which is the rectangular equation of the trajectory.

Putting $y=0$ in the trajectory we get: $x=\frac{v^2 \sin 2\theta}{g}$. Hence, knowing x to be 400 and the angle to be θ, we can find v.

NOTE:—x is found to be a maximum when $\theta=45°$, the angle at which a record throw would perhaps be made.

Hence we have:

$$400 = \frac{v^2 \sin 90°}{g} = \frac{v^2}{g}$$

$$v^2 = 400 \times 32.2 = 12880$$

$$v = \sqrt{12880} = 113.5 \text{ ft. per sec.}$$

Also solved by C. A. Perrigo.

A METHOD OF TESTING OPTICAL GLASS.

It frequently happens that a large object-glass or prism, after going through the long and expensive process of grinding, polishing, and figuring, must be rejected because of internal defects in the glass. Not long ago the Solar Observatory received from a celebrated firm in Germany a large prism which was so defective that the D_1 line seen through the upper part of the prism fell upon the D_2 line observed through the lower part. The figure of the surfaces was excellent, and the whole difficulty lay within the glass. Subsequent attempts to obtain large blocks of glass for prisms have been equally unsuccessful, and as the same difficulty has been experienced with several objectives (including one of 12 inches aperture for the 150-foot tower telescopes), the importance of avoiding the loss of time and the expense thus involved is apparent. It would seem probable that the following simple process of testing glass blocks or disks, without giving them a perfect optical figure, must have suggested itself to others. But perhaps it has serious defects which a trial, soon to be made here, will reveal, for I understand that all opticians now complete the figuring of objectives and prisms before they can discover inequalities of structure less obvious than those shown by the polariscope.

Suppose the block of glass to be in the form of a prism, the faces of which may be polished, but not accurately figured. With the aid of a Zeiss refractometer and some fragments of the prism glass, the index of refraction is measured. The block is then placed in a tank, with two opposite windows of optical glass, the outer face of each a good optical plane, the inner one less perfect. The tank is then filled with a liquid of nearly the same index of refraction as the prism, easily prepared by mixing two liquids of higher and lower indices. Any defects of the prism glass should then be rendered visible with a Michelson interferometer, or by interposing the tank in the path of a beam of parallel light, and applying the knife edge test. If necessary, the liquid may be kept at a constant temperature and stirred during the observations.

If the tank were stably mounted and quite free from vibration, a simple reflecting surface (perhaps even a mercury surface) as its base, returning the light sent vertically downward through the block of glass, might serve in place of the two windows. But in this case the liquid could not be stirred nor the block of glass moved during the test.—*Popular Astronomy.*

ARTICLES IN CURRENT PERIODICALS.

Condor for September-October: "The Discovery of the Nest and Eggs of the California Pine Grosbeak" (with 17 photos by Oluf J. Heinemann and the author), Milton S. Ray; "Notes from Todos Santos Islands," A. B. Howell; "Some Birds of the Saw-tooth Mountains, Idaho," Stanley G. Jewett; "Breeding of the Band-tailed Pigeon in Marin County, California," Joseph Milliard; "Breeding of the Scott Sparrow" (with one photo), F. C. Willard; "White-winged Dove in the San Diegan District," Joseph Dixon; "An Elevated Camp" (with two photos), Charles W. Bowles; "Egrets in California," H. C. Bryant; "Blue Jay Imitating Song of Brown Thrasher," S. S. Visher.

Education for October: "Moral Training in Public Schools," John T. Prince; "College Ethics," Charles Fordyce; "The Training of Rural Teachers," Clara Brooks Fishpaw; "Equality and the Schools," Frank P. Whitney; "Training for Social Efficiency," Laura H. Wild; "Social Hygiene," F. M. Gregg; "Pre-Vocational Training," Charles A. King; "The Special Transfer Class at the Newton Technical High School," Mary A. Laselle.

Educational Psychology for October: "The Child's Speech, I. The Impulse to Speech," Robert MacDougall; "Graded Mental Tests. Part II. Association, Invention, and Construction," Carrie Ranson Squire; "A Comparison of the Binet Tests of 1908 and 1911," Charles Scott Berry; "Pedagogy at the Berlin Psychological Congress," W. Peters.

American Botanist for August: " Phlox Argillacea," Willard N. Clute; "Some Interesting April Flowers," Dr. W. W. Bailey; "Some Minnesota Roses," Lycurgus R. Moyer; "The Yellow Butterfly Weed," Willard N. Clute; "The Cactus and the Desert."

Catholic Educational Review for October: "Problems of the Elementary School," W. J. Fitzgerald; "The Quality of Culture," Thomas Edward Shields; "The Recitation: Its Nature, Scope and Principles," Brother Constantius; "An Educational Explorer in South America."

L'Enseignement Mathématique for September: "Sur les déterminants à plusieurs dimensions," Maurice Lecat; "Qu'est-ce qu'un vecteur?" C. A. Laisant; "Le 5me Congrès International Des Mathématiciens, Cambridge, aout 1912," H. Fehr.

Nature-Study Review for October: "The School Garden and Fundamentals of Education," Otis W. Caldwell; "Indoor Bulb-Planting in Schools," Mary F. Barrett; "The Use of Spring Flowering Bulbs," Grant Smith; "A Feathered Policeman," Harriet Williams Myers; "How to Grow Bulbs for the Schoolroom," H. D. Hemenway; "Nature-Study and Hygiene—II—The Teeth," F. M. Gregg.

Photo-Era for October: "Home-Portraiture," David J. Cook; "Epitaphs," Pictorial Photography and the Art-Critic," Charles J. Adams; "California Camera Club," L. J. Stellmann; "How to Make an Enlarging-Lantern," Wm. S. Davis; "Ortho. Photography with the Focal-Plane Shutter," Phil M. Riley; "A Developer for Underexposed Plates," L. C. Bishop.

Physical Review for September: "On the Theory of Relativity: Analysis of the Postulates," R. D. Carmichael; "On the Motion of a Disc with Three Supports on a Rough Plane," Peter Field; "The Effect of Vibration on the Resistance of Metals," H. L. Brakel; "Reflection of *B* Rays by Thin Metal Plates," William B. Huff; "A Spontaneous Electromotive-Force in Cells of Alkali Metals," Jay W. Woodrow; "Diffraction Grating Method for Determining Index of Refraction," Frederick A. Osborn and Horace H. Lester; "A Study of the Spheroidal State," C. W. Batdorf; "A Theoretical Correction to the Drop Method of Determining the Elementary Charge," Arthur C. Lunn; "The Mechanical Forces between Moving Electric Charges," R. F. Sharpe.

Popular Astronomy for November: "The Recent Disturbance in the Northern Equatorial Belt of Jupiter," with plate XXVII, Latimer J.

Wilson; "Helium Stars Having Bright Lines in Their Spectra," with plate XXVIII, Paul W. Merrill; "The Driving Clock and the Clamp and Slow-Motion Screws of an Equatorial," with plates XXIX, XXX, and XXXI, William F. Rigge; "Rosa Ursina, Sive Sol, a Retrospect," H. D. Curtis; "Use of the Field Glass in Observing Variable Stars," H. W. Vrooman; "Eclipsing Binaries," Harlow Shapley; "Gale's Comet *a* 1912," E. E. Barnard.

Popular Science Monthly for November: "A Round-the-World Botanical Excursion," Charles J. Chamberlain; "Some Aspects of Anaphylaxis," John Auer; "The Permanence of Interests and their Relation to Abilities," Edward L. Thorndike; "China's Great Problem," Thomas T. Read; "Modern Warfare against Grasshoppers," F. L. Washburn; "The Relation of Eugenics to Euthenics," Leon J. Cole; "Negroes Who Owned Slaves," Calvin D. Wilson; "The Administrative Peril in Education," Joseph Jastrow.

School Review for October: "Teaching High School Pupils How to Study," Ernest R. Breslich; "Home-Study Reform," William Wiener.

School Review for November: "Educational Advertising," Neil E. Stevens; "An Inquiry into the Causes of Student Delinquency," W. W. Hobbs, E. Dudley Parsons, D. H. Holbrook, W. H. Shephard; "The Organization of a College Department of Education," E. A. Miller.

School World for October: "The Kinematograph in School," H. O. Hale; "Education at the British Association," H. Bompas Smith; "An Objective Standard in Education," John Adams; "General and Vocational Education," Miss L. M. Faithfull; "Vocational Training in Edinburgh," J. W. Peck; "Teachers and Educational Research," II, T. Raymont; "Eyesight and Typography," Report of British Association Committee; "The Present Position of Mathematical Teaching," (1) William P. Milne and (2) P. Pinkerton.

Unterrichtsblätter für Mathematik und Naturwissenschaften, Nr. 6: "Der chemische Unterricht an den Realanstalten," Prof. Dr. E. Lowenhardt; "Die Berechnung des Kreisinhaltes," Prof. Dr. H. E. Timerding.

Zeitschrift für Mathematischen und Naturwissenschaften Unterricht for September: "Elementargeometrische Behandlung der Kreisteilungslehre," Alb. Schmidt; "Wertigkeit des Tetraederinhalts," Karl Schwering; "Einige einfache Demonstrationsexperimente aus der neueren Physik," Dr. H. Greinacher; "π-Konstruktion," Clemens Brosch; "Bestimmung der Zahl der reelen Lösungen einer dreigliedrigen Gleichung von der Form $x^n = ax + b$ auf graphischem Wege," Oberl Dr. Weil; "Zur Geometrographie," Edited by K. Hagge.

Zeitschrift für den Physikalischen und Chemischen Unterricht for September: "Versuche mit neuen Thermoskop-Rezeptoren," J. Schneider; "Zur Orientierung photographischer Aufnahmen einer Sonnenfinsternis," K. Hoecken; "Schülerübungen im physikalischen Anfangsunterricht," Beck; "Neue chemische Unterrichtsapparate," J. Lang.

A PROJECTOSCOPE FOR THE HOME.

There has recently been placed on the market by the Bausch and Lomb Optical Co. a new Model B Balopticon for projecting slides in your own home for the benefit and pleasure of one's friends. There is nothing better, for the price, to use in any small room than their Model B. It is easily operated by persons with no experience in this kind of work. They furnish a 100-watt special Tungsten lamp with the lantern. It can be used on the ordinary house-lighting circuit. This is just the lantern with which to entertain in one's home, showing slides of photographs which one may have taken in traveling. The price is only $18.00. Write the firm for full information.

AN INSTITUTE THAT STARTS WITH $10,000,000.

Few institutions of learning have begun their existence under such auspicious circumstances as the William M. Rice Institute, which opened its doors this fall at Houston, Tex., with an original fund for $10,000,000 for endowment and maintenance; with the foremost educators in the nation aiding in planning its future; with picked men for administrative offices and faculty; and with a vigorous, growing country in which to prosper and wield its influence. It is small wonder that the opening of this institution should be attended by noted educators from all over the world, as well as official government representatives. Dr. P. P. Claxton, United States Commissioner of Education, deputized as special representative of the Bureau at the ceremonies Dr. Kendric C. Babcock, specialist in higher education.

Rice Institute was made possible by the munificence of William Marsh Rice, a native of Massachusetts, but for many years a resident of Houston. Before his death in 1900, Mr. Rice made far-reaching plans for the establishment of a nonpolitical and nonsectarian institution to be dedicated to the advancement of letters, science, and art. During the long period of litigation that followed Mr. Rice's death, the trustees called Dr. Edgar Odell Lovett, a professor in Princeton University, a man of wide experience and lofty aims to aid them as president in realizing the founder's aspirations. President Lovett was instructed to learn all he could about other institutions of higher learning before beginning his own. He traveled all over the world in the interest of the new enterprise, visited the leading educational and scientific establishments, and returned in the summer of 1909 from a year's journey of study that extended from England to Japan. Meanwhile the trustees had secured 300 acres of land on the extension of Houston's main thoroughfare as a site for the institute, and engaged experts to begin upon a comprehensive architectural plan that would embody in succeeding years the purposes of the institute. This fall building operations had progressed so far that it was deemed advisable to hold formal dedication exercises and to open the institution to students.

As a result of the systematic planning for the future, the buildings of Rice Institute will be a real contribution to American architecture. Evolved from the best European types, yet carefully adjusted to the climatic conditions of the Southwest, the buildings will illustrate a distinctly appropriate style of architecture. The institute will not grow in a sporadic and haphazard manner, like so many American colleges and universities, but will develop symmetrically in accordance with a preconceived plan. Conspicuous among the buildings projected will be the special laboratories for instruction and investigation in physics, chemistry, and biology, and in the application of these sciences to the arts of industry and commerce. In drawing the laboratory plans the institute authorities had the active cooperation of men like Professor Ames of Johns Hopkins; Professor Conklin of Princeton; Professor Richards of Harvard; and Professor Stratton, director of the National Bureau of Standards.

The institute will be open to both young men and young women. There will be no charge for tuition and no fees.

The standards of the institute will be consistently high: "For the present it is proposed to assign no upper limit to the educational endeavor of the new institution and to place its lower limit no lower than the standard entrance requirements of the more conservative universities of the country." Besides providing work of regular collegiate grade, the

institution will afford opportunities for research to a number of selected graduate students.

Thus Rice Institute has begun a career which seems destined to add one more illustrious name to the growing list of notable universities and colleges that are doing much to create an American culture.

IRIDIUM A RARE METAL.

The smooth writing qualities possessed by gold fountains pens may be attributed to the tiny bit of white metal—iridium—fastened to the tip of the pen. Iridium is an exceedingly rare metal, according to the United States Geological Survey, not more than 5,000 ounces being produced each year, of which perhaps about 500 ounces are recovered in the United States, mostly from imported platinum sand and from copper ores and bullion. The price demanded for iridium has been increasing rapidly, and in 1911 it ranged from $60 to $64 an ounce for pure metal.

Owing to its unique qualities, iridium finds a fairly extensive use. Most of the metal produced is probably used for hardening platinum. It is further used for various scientific and technical purposes, such as standard weights, pivots, contact points, and as previously stated, for gold-pen points. Iridium black, an oxide of the metal, is highly valued as a pigment for decorating chinaware.

According to the Bureau of Statistics, 3,905 troy ounces of "iridium and iridium in native combination with platinum metals," valued at $210,616, were imported into the United States in 1911.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS.

The twelfth meeting of the Central Association of Science and Mathematics Teachers will be held at the Northwestern University, Evanston, on Friday and Saturday, November 29 and 30. The Great Northern Hotel, Chicago, has been selected as headquarters for out of Chicago members and friends.

The addresses at the general sessions will be given by Professor W. C. Bagley of the University of Illinois and Carroll G. Pearse, Superintendent of Public Schools, Milwaukee, Wisconsin. They will discuss some of the important phases of present-day educational problems.

The programs of the five sections contain the names of many of the prominent educators of the Middle West and provide for many reports and discussions of a practical nature which will prove of great interest and value to teachers of science and mathematics. The program of the meeting will be printed and distributed within a few days.

Persons engaged in teaching science or mathematics, or in superintending such teaching are eligible for membership. All such persons are invited to join the association. Annual dues, $2.50. In addition to membership each person will receive without further cost the monthly official journal, SCHOOL SCIENCE AND MATHEMATICS, and a copy of the Proceedings, at the same time having all the advantages which come to one who is a member of a great and active association as this.

Address all communications to the Secretary-Treasurer, C. E. Spicer, 100 Sherman Street, Joliet, Ill.

ENGINEERING EDUCATION.

Our readers are requested to notice the report of Committee on Teaching Mathematics to Engineering Students. This book will be a help to all teachers of mathematics, especially those who are preparing students for engineering schools. It tells teachers what are considered the fundamentals of engineering subjects. It is a handy syllabus for engineering students who wish to become familiar with certain fundamental theorems.

SOME NOTES OF THOUGHT ON EDUCATION.

By Arthur E. Haynes,
University of Minnesota.

Our whole system of education tends to the *extensive* rather than to the *intensive;* too many subjects are taken to enable the pupil to be thorough in any.

Such a method produces distraction rather than abstraction, confusion instead of order, dimness instead of clearness, and makes the pupil more like a parrot than a real student.

"Going through books" does not necessarily educate one, any more than walking through beautiful gardens makes one a botanist. Discipline of mind requires real study, it involves self-activity of the mind in careful, independent thinking. Too many subjects taken in too little time, blast the finest fruit of education—the power of logical, consecutive thought.

It is good, wholesome food, thoroughly digested and assimilated, that nourishes and builds up the body; bolting food down leads to physical stomach ache and bodily disorders. It is healthful, strong thought, carefully considered, that sustains and produces mind development; overcrowding the mind, leads with equal certainty to intellectual dyspepsia.

The development of the power to apply knowledge to useful purposes ought to be one of the highest aims of education: the teaching of one how to so apply his knowledge makes his study many fold more interesting and encourages in him both confidence and self-respect. This is what renders the study of engineering and of other professions so attractive.

The old adage: "Knowledge is power," is true only as one can intelligently and wisely apply it.

The educational world is rapidly changing its activity to more reasonable and practical methods. It is a time in the history of education which requires the most careful and wise forethought. This activity, if properly directed, will result in great progress.

God honors man by giving him the divine privilege of discovering, proclaiming and using the truth; happy and fortunate indeed, is the one who sincerely consecrates himself to this noble task. Even the Sacred Word admonishes us to "buy the truth and sell it not;" while "The Master of Souls" said: "Ye shall know the truth and the truth shall make you free."

These divine words contain one of the mightiest and most beneficent laws of the kingdom of education, and of life; they are the very foundation of bodily, intellectual and soul freedom. Thrice blessed is the one who knows the truth and applies his knowledge wisely to this triple realm of his life.

FUSING PLATINUM IN QUARTZ.

How to fuse platinum wires into quartz tubes, so as to make a good joint, is no small problem. M. Berlemont presented his new method to the Academie des Sciences not long since, and claims to have been successful. The difficulty is that quartz melts at as high a heat as 800 deg. Cent. and has a very small expansion value, while all the metals expand to a much greater extent and also melt at a lower temperature. After numerous attempts to make a joint, first by direct fusion, and then by an indirect method, such as the use of glass or enamel, oxides or electrolytic deposits between the wire and the quartz, M. Berlemont came back to the direct method of imbedding the metal in the quartz, using a platinum-iridium alloy. By an approved process, requiring some skill, he could make a tight fused joint which would stand a high heat without damage, and was thus able to make all kinds of quartz tubes with fused electrodes.—*Scientific American Supplement.*

HISTORY OF THE POTOMAC RIVER.

The great Potomac gorge was not always, as it is to-day, one of the most beautiful and picturesque of river valleys. The United States Geological Survey has recently published a geologic folio describing about 460 square miles including a portion of the Potomac Valley. It contains a most interesting account of the gradual cutting down by the river of this deep gorge during thousands of years.

The area is located in a part of the Potomac Valley where the river winds in great curves through a deep gorge with densely wooded slopes. As the railroad traveler swings around these sharp bends which almost meet before they reverse and realizes that it takes three times as long to ride between two points as it would to go in a straight line, he may wonder how the river acquired such a course.

In a view from the tops of the ridges, it can be seen that many of the hilltops are flat and of about the same altitude, and that if the valleys were filled up they would form a nearly level plain. This feature is also excellently shown by the topographic map which forms a part of the folio. Many thousand years ago the Potomac flowed toward the sea upon this plain, which at that time was much lower in altitude—in fact, so near the level of the sea that the stream was very sluggish and wandered about in its valley, as is the custom of streams with low grade, such as the Mississippi. Later, when the interior of the continent was somewhat elevated, the streams became "rejuvenated" and cut down their channels, first into the soft detritus which had accumulated in the flat valley and eventually into the hard rocks beneath. As the continent rose still higher, they cut deeper into the rocks, and, as a result, the Potomac is now deeply intrenched in these winding gorges.

Other features which the traveler may observe from the car window in passing through this area are the great rock folds. One arch of rock that has been truncated by the river and is visible from the train is of such interest to geologists that it has attracted visitors from all parts of the world and is illustrated in most text-books on geology. Other folds, not visible from the train but readily accessible to those interested, have the form of great saw teeth rising above the crest of a hill. These rock folds are the record of the great mountain-making forces which crushed and folded the rocks as they were raised out of the sea.

INFORMATION AT THE BUREAU OF EDUCATION.

The Commissioner of Education calls attention to the opportunities offered by the Bureau of Education to students of education and to such committees and commissions as are appointed by state boards of education and national, state, and local associations for the purpose of investigating particular phases of education. Here students and the representatives of such committees and commissions may find at once and without cost other than that of coming to Washington practically all that is now in print in pamphlets, books, or magazines on any subject of education, including educational legislation. The Bureau does not now have all the expert help it should have to put at the service of students and representatives of committees and commissions to assist them in working out their problems, but it will gladly give them such assistance as it can, and a room in the Bureau has been set apart for their use. In a few days or weeks information can be obtained here which these committees and commissions frequently spend months of time and hundreds of dollars in trying to collect by correspondence. When the Bureau has more money than is now appropriated for its use, it will be able to help more than it can at present by serving as a kind of working subcommittee for all the more important commissions of its kind.

FORMATION OF THE EARTH'S SURFACE.

At a recent meeting of the Geological Association at Frankfort-on-the Main, Dr. Wegener of Marburg University suggested an interesting hypothesis on the genesis of the earth's surface. According to this, the present form of the surface would be due to vertical and horizontal displacements. The continental blocks, i. e., the different parts of the world, such as Europe, America, etc., are capable of vertical displacement, like blocks of floating ice. As soon as an increased load is brought to bear on them, the blocks will sink down. Such an increasing load may be due to the continental ice covering the country. According to the author's preliminary calculations, a load of 2.6 meters of ice would entail a drop of 1 meter. Horizontal displacements likewise occur continually, as shown by the relative displacement of continents. Lunar observation for instance show Greenland to have moved 940 meters farther away from Europe in the course of 84 years. On the other hand, determinations of the distance between Greenwich (England) and Cambridge (America), have revealed the surprising fact that North America, in the course of 26 years, has withdrawn another 90 meters from Europe.—*Scientific American Supplement.*

THE TWO-STORIED PAGE OF WEBSTER'S NEW INTERNATIONAL DICTIONARY.

(G. & C. Merriam Co., Springfield, Mass.)

The treatment of so great a bulk of material by the usual dictionary method would have made it almost inaccessible. By a stroke of genius the editors decided on a two-storied page, relegating to the lower part obsolete words (gubbertushed, nawyse), those defined only by cross reference (Lacy's knot), uncommon dialetic words (unco), rare scientific terms (lacturamic), abbfeviations (U. S. A.), and all except the most common Scriptural names, names of fictitious persons, and foreign phrases. This leaves to the upper part of the page all that a person ordinarily will wish to know; everything else is in the bottom section. There is no mass of confusing appendixes to waste time over.

CHICAGO TEACHER'S EXAMINATION.

Examinations for certificates will be held Monday, December 23, and Tuesday, December 24, 1912, for the following certificates only:

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Examinations will be given in the following high school majors only, with their accompanying minors:

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The maximum salary in the Chicago city high schools is $2,600.

Write the Examiner, Board of Education, Tribune Building, for further information.

AMERICAN CONTROL OF THE PANAMA CANAL.

The people of the United States, in opening this canal, are conferring a great boon upon the commerce of the world, and they are especially contributing to the development of South America. In the adjustment of tolls, and in the use of the canal for the promotion of our own commerce, it would be incredible that we should be thought to have placed obstacles in the way of our own freedom of judgment. There has been much discussion of this question, based upon a wholly inadequate study and knowledge of the subject. The Government of the United States will treat all foreign nations equally and fairly, and will treat its own citizens precisely as it thinks best. A similar principle is involved in the question of fortifying the canal. We had long ago entered upon a systematic plan of creating modern coast defenses. Such a system is ridiculous if the defenses are not located at the strategic points. The Panama Canal is in some respects our most strategic piece of navigable coast line. If we are fortifying at any points, it would seem absurd to leave unfortified the passage by which navies could go from one ocean to the other. Furthermore, an unfortified canal would be exposed to dynamite outrages which would render it impassable at a time when it might be necessary to send our fleet from the Atlantic to the Pacific, or *vice versa*. The people of the United States are conscious of pacific intentions toward all countries. They have no aggressive ambitions. In this regard they are more fortunate than are some other peoples and governments.—*Review of Reviews.*

BACK NUMBERS WANTED.

We need copies of the following numbers to complete orders for full sets, and will pay 50 cents cash or $1.00 in subscription for copies in good condition: Vol. 1, No. 2, April, 1901; Vol. 1, No. 9, February, 1902; Vol. 4, No. 1, April, 1904; Vol. 7, No. 8, Nov., 1907.

SURVEYING WITH THE CAMERA.

The first extensive use of the panoramic camera to supplement the plane-table in surveying is said to have been that made by Mr. J. W. Bagley of the United States Geological Survey, in mapping an area of 160 square miles around Valdez, Alaska, during the season of 1911. This method promises to become a regular feature of the Survey's work in Alaska.

CAPE DESHNEF.

The extreme northeastern corner of Asia is still called "East Cape" in many atlases and other geographical works. The *Bulletin* of the American Geographical Society calls attention to the fact that the name of this point was changed to "Cape Deshnef" in 1898 by command of the Emperor of Russia, in honor of the explorer who discovered it.

ELECTROLYSIS ORDINANCE IN CHICAGO.

The city council of Chicago has recently passed an ordinance requiring certain electrical equipment to prevent damage by electrolysis. It requires that the difference of potential between any two points on a return circuit must not exceed twelve volts and between any two points on the return a thousand feet apart, within one mile radius of the city hall shall not exceed the limit of one volt, while between any two points on the return seven hundred feet apart, outside of this mile radius, it will not exceed the limit of one volt. Return current amperage on pipe and cable sheaths must not be more than five-tenths ampere per pound-foot for caulked cast iron pipe, and eight amperes per pound-foot for screwed wrought iron pipe, and sixteen amperes per pound for standard lead or lead-alloy sheaths of cable.—*Scientific American Supplement.*

BOOKS RECEIVED.

A Text-Book of Physics. Edited by A. Wellmer Duff. Third edition revised. Pages xvi+686. 595 illustrations. 15x21 cm. Cloth. 1912. P. Blakiston's Son & Co., Philadelphia.

College Zoölogy, by Robert W. Hegner, University of Michigan. Pages xxiv+733. 14x19 cm. Cloth. 1912. $2.60 net. The Macmillan Company, New York.

The Calculus, by Ellery W. Davis and William C. Brenke, University of Nebraska. Pages xx+384+63. 13x19 cm. Cloth. 1912. $2.00 net. The Macmillan Company, New York.

Essentials of Physics, by Daniel W. Herring, New York University. Pages ix+353. 15x23 cm. Cloth. 1912. $1.75 net. D. Van Nostrand Company, New York.

Durrell's Arithmetics, two book series, by Fletcher Durell, Ph.D., Head of the Mathematical Department the Lawrenceville School, Lawrenceville, N. J., and Elizabeth Hall, Supervisor of Primary Schools, Minneapolis, Minn. Elementary Arithmetic, 354 pages. 14x19 cm. Cloth. 48 cents. Advanced Arithmetic, 458 pages. 14x19 cm. Cloth. 64 cents. Charles E. Merrill Company, New York.

A College Text-Book on Quantitative Analysis, by Herbert R. Moody, College of the City of New York. Pages vi+165. 15x22 cm. Cloth. 1912. $1.25 net. The Macmillan Company, New York.

Syllabus of Mathematics. Compiled by the Committee on the Teaching of Mathematics to Students of Engineering. Pages iii+136. 15x22 cm. Cloth. 1912. 75 cents. H. H. Norris, Secretary Cornell University, Ithaca, N. Y.

Teacher's Manual of Biology, by Maurice A. Bigelow, Teachers College, Columbia University. Pages ix+113. 13x19 cm. Cloth. 1912. 40 cents net. The Macmillan Company, New York.

The Teaching of Plane Geometry, by H. Y. Benedict and J. W. Calhoun, University of Texas. 57 pages. 15x23 cm. Paper. 1912. Press of the University of Texas, Austin.

Text-Book of Anatomy and Physiology for Nurses, by Elizabeth R. Bundy, Woman's Hospital of Philadelphia. Pages xii+335. 16x23 cm. Cloth. 1912. $1.75 net. P. Blakiston's Son & Co., Philadelphia.

Essentials of Chemistry, by John C. Hessler, James Millikin University, and Albert L. Smith, Englewood, Chicago, High School. Revised by John C. Hessler. Pages xix+505+xxxiii+v+121. Cloth. 1912. Benj. H. Sanborn & Co., Chicago.

Elementary Text-book on the Calculus, by Virgil Snyder and John I. Hutchinson, Cornell University. 384 pages. 14x19 cm. Cloth. 1912. American Book Company, Chicago.

A Laboratory Manual of Agriculture for Secondary Schools, by Leland E. Call, and E. G. Schafer, Kansas Agricultural College. Pages xv+344. 13x19 cm. Cloth. 1912. 90 cents net. The Macmillan Company, New York.

Plane and Solid Geometry, by C. A. Hart, Wadleigh High School, New York City, and Daniel D. Feldman, Erasmus Hall High School, Brooklyn. Pages viii+488. 14x19 cm. Cloth. 1912. American Book Co., Chicago.

BOOK REVIEWS.

Practical Theme Tablet, by George M. Miller. 75 pages. 20x26.5 cm. 20 cents. Hinds, Noble and Eldredge, New York.

A tablet which will be most helpful to the pupil in writing his themes. The front cover has printed on it rules for punctuation, etc., as well as an outline for correct theme work, together with a key to the teacher's corrections. A blotter is firmly bound in next to the front cover. An extra heavy board back is used. The paper is of high quality, horizontally ruled with a red line 25 cm from left hand edge. No better tablet for the price is made. C. H. S.

Comparative Anatomy of Vertebrates, by J. S. Kingsley, Professor of Biology in Tufts College. Pages ix+401. 16x23 cm. With 346 illustrations. 1912. $2.25 net. P. Blakiston's Sons & Co.

This book by Professor Kingsley will be welcomed for use with college classes and for a reference book by the high school teacher. The style is clear and direct and the illustrations are particularly fine—all of them being drawings made especially for this book. There are numerous schematic drawings which will help the student to a correct understanding of the subject-matter.

The mechanical make-up of the book seems to be excellent. The type is clear and well spaced. We note one drawing, fig. 22, printed upside down. Doubtless an accident.

The plan of the book follows that of the well-known German text of Weidersheim—taking up the various systems of organs in succession and making a comparative study of each through the various groups of animals including their development. An extensive bibliography of monographs, used as sources of material for the book will be especially useful to the student who wishes to go to the original papers on any special topic.

W. W.

New Analytic Geometry, by Percey F. Smith, Ph.D., Sheffield Scientific School of Yale University, and Arthur S. Gale, Ph.D., University of Rochester. Pages x+342. 13x19 cm. Price, $1.50. 1912. Ginn & Co., Boston.

In many respects this volume is a decided improvement on the current text-books in analytic geometry. While presenting material for a thorough drill in the use of analytic methods which have been considered of the highest importance for many generations, the authors have given attention to the present-day demands for simple, useful, and practical methods and problems. For a short course in analytic geometry the instructor can find in this book sufficient material to prepare his students to attack with intelligence problems that come up in their later work. On the other hand, the instructor who still believes in the study of mathematics for mental discipline, etc., will find plenty of material for his purposes.

The chapter on transcendental curves and equations is very useful, and tables are given to facilitate the plotting of curves. Polar coördinates are presented in considerable detail, and the student is taught how to make sketches of curves rapidly. Maximum and minumum values can usually be determined with sufficient exactness from a graph, and there is a good list of problems for this work. The equations of the parabola, ellipse, and hyperbola are derived by methods easily grasped by the student, and methods of constructing and sketching these curves are given. Equations of tangents are found by the method of the calculus disguised. Why is not this a good place to give students an opportunity of learning one of the meanings of $\frac{dy}{dx}$? The chapter on parametric equations and loci gives a simple and clear treatment of the subject, and the more important equations are discussed and their graphs given. The chapter on empirical equations is placed at the end of the book. It would seem as if the subject were of sufficient importance to be included in the body of the book.

The discussion of solid analytic geometry fills one hundred pages; and here as in the rest of the book the figures and diagrams are well drawn and illuminating.

H. E. C.

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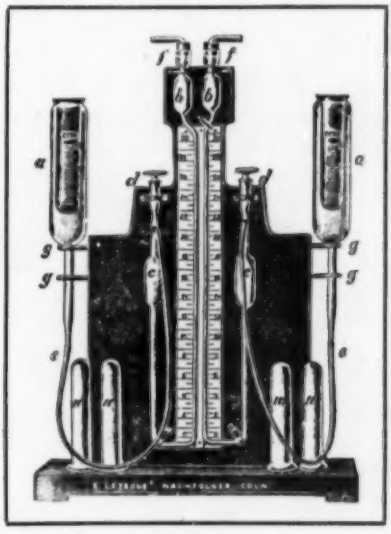

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Teachers' Manual of Geography, by W. T. Skilling and Alice Greer. 1912. Issued by the State Normal School, San Diego, Cal.

A manual of use to teachers in elementary and grammar school geography. The main value of the manual is the well-planned references to the descriptive accounts of various counties. The references which have been chosen are those of practical use to the teachers and are generally accessible in the ordinary school library. W. M. G.

The Story of Bread, by E. L. Barker. 30 pages. Published by the International Harvester Company, Chicago, Ill.

The complete story of wheat growing, including the breeding of the seed, its planting, and the harvest. The advantage of machinery in harvesting and the progress in its application to wheat growing is clearly described. This little pamphlet is of value to the commercial geography class. W. M. G.

High School Geography, Physical, Economic, and Regional, by Charles Dryer. 535 pages, 37 chapters, 369 figures and colored maps. 1912. $1.20. American Book Company.

This is the first of the new texts to appear as a result of the demand from the secondary schools for a course in geography which embraces less of the systematic physiography and more of geography. The author divides the subject-matter into three parts: I, Physical; II, Economic; III, Regional.

The section devoted to Physical Geography has been especially written to give the student a basis for the intelligent comprehension of the physical factors which help or hinder men in his progress. There is an omission of much material which has burdened the usual physical geography and many subjects have been humanized as illustrated by the various chapters on soils, economic relations of streams, coasts and ports. Economic geography is a term new in the secondary texts but is well to recognize it as one of the three distinct geographic controls which determine the location of industries and the growth of cities. The four chapters devoted to the economic factors deal with the Natural Resources and Food Supply, Clothing, Heat, Light, Power, Manufacture, Trade, and Transportation. These topics are clearly presented and their geographic importance is distinctly emphasized. The discussion of these questions afford pupils opportunity to reason with problems of vital concern to them and it is a new element of geography which will be welcomed by the secondary schools.

The Regional geography comprises about one hundred pages dealing with the natural provinces of the world following somewhat the plan of Herbertson in the classification of these regions. In the discussion of North America and the United States it seems to the writer that there is some confusion in not following the physiographic regions. It would strengthen the geography of the United States to have the physical and political facts included in the physiographic account of each region. The treatment of Europe is excellent, especially the British Isles where the three geographic controls, the physiographic, economic, and the human, are well woven together in a systematic description. Asia, South America, and Africa receive ample attention considering their importance.

Altogether this book for High School Geography is a very marked improvement upon the texts which the teachers of Physical Geography have been using and further improvements along these lines will give geography a more important place in secondary education.

W. M. G.

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A Text-book of Physiology, including a section on physiologic apparatus, by Albert P. Brubaker, A.M., M.D., Professor of Physiology and Medical Jurisprudence in the Jefferson Medical College. Fourth edition revised and enlarged. Pages xii+736. 17x24 cm. 378 illustrations. 1912. $3.00 net. P. Blakiston's Son & Co., Philadelphia.

The chief point in this book's favor is the clearness with which the subject-matter is stated. The arrangement into paragraph and section greatly aids this clearness of presentation. The point of view seems to be distinctly medical—as the author, in fact, so states in the preface. The exposition of the function of various tissues and organs seems to be particularly strong. The treatment of the main topics is, however, rather unequal, as, for example, we find 100 pages given to the consideration of blood and circulation while only 120 pages are given to the nervous system including the special senses. The illustrations are somewhat scanty, there being only one for two pages of text on the average and they cannot be said to compare well in character with those of other recent texts.

However, the book can be recommended as a good text for reference for the teacher who wishes something convenient and satisfactory for this purpose and who cannot have access to monographs on the various divisions of the subject of physiology. W. W.

Plane Geometry, by William Betz, Rochester, N. Y., and Harrison E. Webb, Newark, N. J. Pages x+322. 14x19 cm. Price, $1.00. Ginn and Company, Boston.

In the preparation of this book the authors have been led by their experience in high schools to meet the new educational demands by basing their work on the following principles: (1) To introduce the demonstrative course by a preliminary course. (2) To arrange the demonstrative course not only along logical but also psychological lines. (3) To follow methods which aim to make the pupil independent of the book. (4) To give approximately equal attention to the different types of exercises. (5) To provide applied problems numerous, but not excessive in number. (6) To include a minor and major course, in order that the teacher may adapt the text to the special needs of a particular class of pupils.

The preliminary course occupies the first sixty-eight pages, and aims to give pupils a grasp of the fundamental notions of geometry by drawing and constructing figures with ruler, compasses, and protractor. The exercises seem to be well chosen. Though this preliminary course requires five or six weeks, the authors say that careful tests in many classrooms have proved that time is saved by it. This is in accord with the experience of other teachers who have given similar introductory work.

The part of the text given to demonstrative geometry is divided into the usual five books. Teachers of geometry in this country have much to learn from the recent marked advance in the teaching of geometry in England, and the authors are to be commended for giving American teachers the opportunity of trying out some of the English ideas. Especially is it worthy of note that areas have been introduced early. This gives a larger opportunity for numerical and applied problems. The fundamental *principle*, "Area of a rectangle equals the product of base by altitude," eliminates several propositions of doubtful value to the average pupil.

The use of squared paper, Simpson's rule and the trapezoidal rule, a more extended use of the trigonometrical ratios, drawings and constructions, and many problems and exercises dealing with practical affairs, are some of the features that make this a very welcome book.

H. E. C.

Elementary Applied Chemistry

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IN his years of successful campaigning for pure foods and honest values in his own community, the author has gained through practical experience the knowledge which is presented in this manual and which has long been demanded by school officials and teachers. The book consists of numerous exercises with common substances—good products, water, soil, textile fabrics, and many others—aiming to make chemistry a living issue and to give the pupil a broader outlook on the science in general. The exercises have already proved of personal value to hundreds of students, and teachers of domestic science, boards of health, food inspectors will find that the book has a specific purpose.

Practical Botany

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THIS botany meets the great and increasing demand for a textbook which shall present the subject in a scientific manner and, at the same time, emphasize the relations of plants to everyday life. It contains ample material to prepare students who wish to present a unit for entrance to college, but its point of view is not that of the technical botanist. The book is designed rather to give that kind of outlook upon the science which will enable the pupil better to appreciate the economic and the æsthetic significance of the plant world, as well as to understand the elements of biology as they are shown in the life of plants.

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By a special arrangement with the Publisher we can offer this book with SCHOOL SCIENCE AND MATHEMATICS for a year for $3.00.

A Working Model for Schools, by Don Carlos Ellis. 10 pages and 4 illustrations. Issued by the United States Department of Agriculture, Circular No. 117, Washington, D. C. 1912.

A full explanation of a model which illustrates the effect of erosion upon a forested region and a deforested area. The working drawings are sufficiently clear and definite, so that the teacher can make such a model at small cost and with good results. W. M. G.

Principles of Human Nutrition, A Study in Practical Dietetics, by Whitman H. Jordan, Director of the New York Agricultural Experiment Station, author of "The Feeding of Animals." Pages xxi×450. 1912. Net $1.75. The Macmillan Company, New York.

According to the author's preface this book is intended to be a popular presentation of the subject for the use of students and others who have but "moderate scientific acquirements." "Reliable knowledge bearing on the nutrition of man is mainly to be found in elaborate works on physiology and physiological chemistry, the contents of which are not generally available." "The aim here, has been to show the adjustment of this system of knowledge to a rational system of nutrition."

The book seems to be a painstaking presentation of the subject of nutrition from the point of view mentioned above. No doubt such a work is needed. Food economics is emphasized throughout. We find such topics as these: "Cheap and Costly Meals," "Two Dinners Compared," "Food and Social Welfare," etc.

There are many tables through the body of the book, besides nearly 100 pages of tables showing the chemical composition of foods. These should be especially helpful. The book should be a useful one for the teacher of physiology. W. W.

Elements of Physics, by Edwin Herbert Hall, Professor of Physics in Harvard University. Pages viii+576. 13x19 cm. Cloth. 1912. Henry Holt & Co., New York.

This excellent text is much more than a revision of Hall and Bergen's "Text-book of Physics." It is practically a new book.

It has been written from the standpoint of the abilities and needs of "beginners in the systematic study of physics" though "intended for the later years of a school course or the first year of a college course, rather than for earlier use."

In the several subjects the order of topics selected is, in general, to present first the phenomena of common experience and ready comprehension. Thus the topic of accelerated motion is deferred until after mechanics of fluids, machines and parallelogram of forces are studied.

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Directions for fifty laboratory exercises are placed at the end of the book where they occupy seventy-two pages. A number of changes from the list found in the Hall and Bergen text is noted, making it more up to date and practical.

The illustrations are good, being as a rule simple, easily understood diagrams. Two hundred and seventy-nine of these are in the text while sixty-six illustrate the fifty laboratory exercises. Fine full-page portraits of celebrated physicists are also included.

It is a good, teachable book, and deserves to be widely used.

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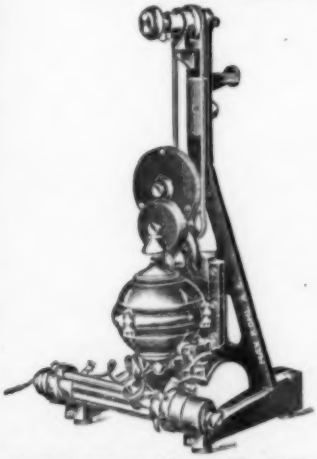

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Work and Play with Numbers, by George Wentworth and David Eugene Smith. Pages, 144. 14x19 cm. Price, 35 cents. 1912. Ginn & Co., Boston.

This book presents the number work for the first and second grades, and has been planned to interest young children in number relations. The many colored pictures, large type, and well-spaced pages make it an attractive book. Teachers in the first grade should not fail to examine this little book. H. E. C.

The American Geographical Society. Guide Book for the Transcontinental Excursion for 1912, by Professor W. M. Davis. 144 pages and 24 figures. Ginn and Company.

The American Geographical Society celebrates the sixtieth anniversary of its founding by a Transcontinental Excursion from New York to San Francisco. This guide book was compiled by Professor W. M. Davis for the use of the members of the Excursion and it has some excellent examples of geographic descriptions which will be very useful to the high school teacher. The Guide consists of Part I, the Physiographic Provinces of the United States; Part II, the Daily Itinerary of the Excursion. The former gives a general physiographic description of the region and the latter gives the details of the region visited from day to day during the trip. W. M. G.

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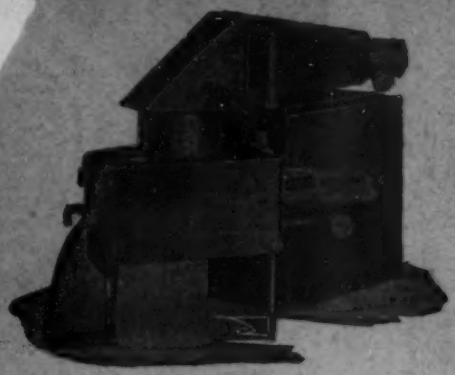

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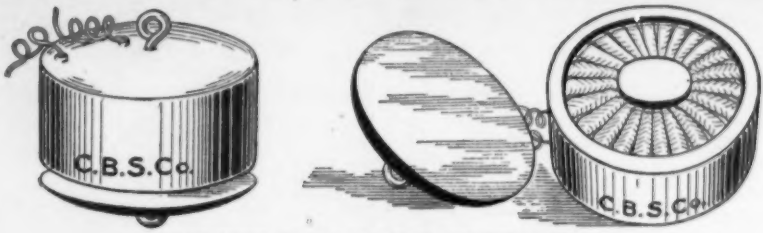

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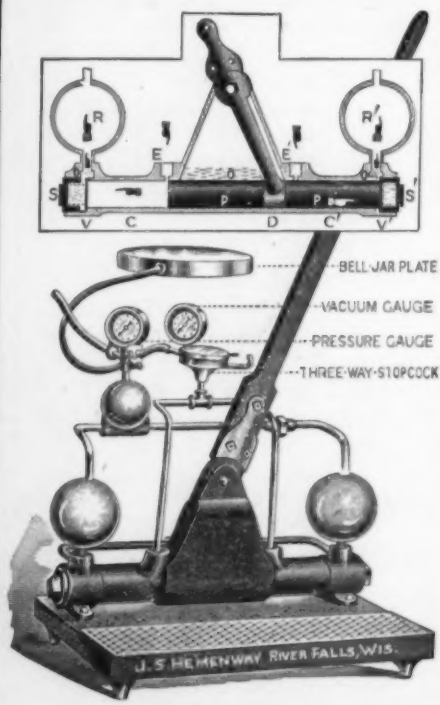

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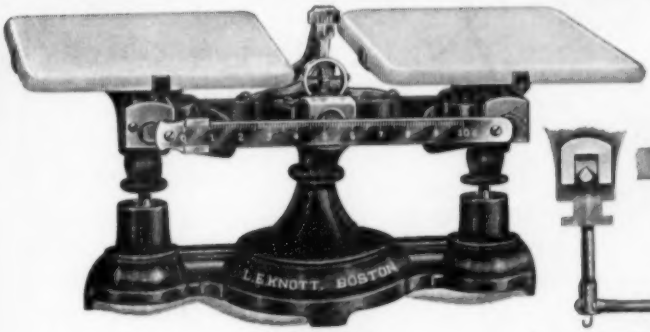

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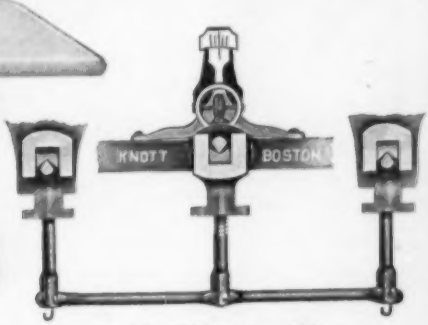

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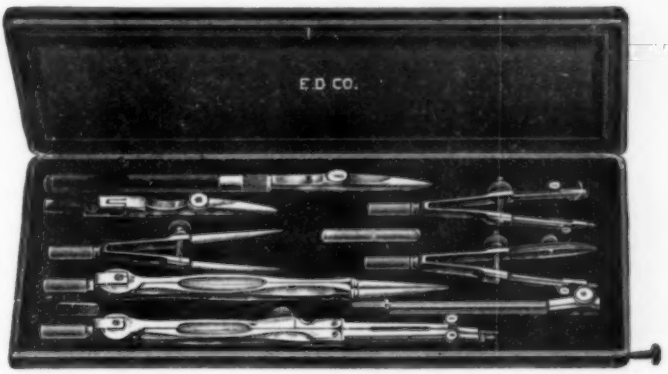

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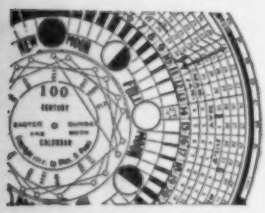

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